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Volume 17, Number 1 April 14, 1971

DIGENETIC TREMATODES OF MARINE FISHES FROM THE FLORIDIAN NORTHERN GULF OF MEXICO

FUAD M. NAHHAS
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and

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GENERIC KEY AND SYNOPSES FOR FREE-LIVING LARVAE AND TADPOLES OF MEXICAN AMPHIBIANS

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NEW OR LITTLE KNOWN SPECIES OF TROPICAL FUNGI

A. L. WELDEN
Department of Biology, Tulane University, New Orleans, Louisiana p. 16

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Assistant to the Editors

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Volume 17, Number 1 April 14, 1971

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ABSTRACT

Seventy-three fishes representing 50 species from the Northern Gulf of Mexico in Florida were examined for digenetic trematodes. Thirty-two species harbored 27 Digenea. Two new species are described: the hemiurid *Ectenurus* ***yamagutii*** from *Caranx crysos*, *C. hippos*, and *Lagodon rhomboides*, and the lepocreadiid *Lepocreadium* ***sogandaresi*** from *Eupomacentrus leucostictus*. *Monascus filiformis* (Rudolphi, 1819) Looss, 1907 (Fellodistomatidae), known previously from the Mediterranean and reported for the first time from North American waters, is described and figured.

INTRODUCTION

This is the third paper on the Digenea of marine fishes from the northern end of the Gulf of Mexico. The first two (Nahhas and Short, 1965; Nahhas and Powell, 1965), included a description or report of a total of 53 species from Apalachee Bay. The present

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material was collected by the junior author during 1967 and 1968. All fishes examined were captured in Pensacola Bay and neighboring waters with the exception of four specimens of *Eupomacentrus leucostictus* from Panama City, Florida. Seventy-three fishes representing 50 species were examined. Digenea were washed in saline, fixed in alcohol-formalin-acetic acid (A.F.A.) under slight coverslip pressure, stained with acetocarmine, dehydrated in a graded series of alcohol, cleared in methyl salicylate, and mounted in Kleermount® (Carolina Bio. Supply Co., Burlington, N. C.). A few immature trematodes or those represented by a single specimen not suitable for study were not included. Figures were drawn with the aid of a microprojector. Measurements are in millimeters except when otherwise stated. Holotypes of new species are deposited in the U. S. National Museum Helminthological Collection. Asterisks preceding host names indicate new host records.

Acknowledgments

The authors wish to acknowledge with thanks the assistance of: Dr. H. W. Manter of the University of Nebraska, who helped in the identification of *Monascus filiformis* (Rudolphi, 1819) Looss, 1907; Drs. S. Yamaguti and F. Sogandares-Bernal for examining specimens of *Ectenurus yamagutii*; Mr. J. K. Haburay who helped in collecting fishes; Dr. Camm Swift for the identification of some of the fishes; and Dr. M. M. Nez of Pensacola Junior College for the use of laboratory space and equipment.

Description and Discussion of Species

Family Acanthocolpidae Lühe, 1909

Stephanostomum megacephalum Manter, 1940

Host: Caranx hippos
Site: Intestine
Locality: Santa Rosa Sound

Family Bucephalidae Poche, 1907

Bucephalus brevitentaculatus Corkum, 1967

Host: Trichiurus lepturus
Site: Ceca
Locality: Pensacola Bay

Our nine specimens are in complete agreement with the description by Corkum (1967). The tentacles are difficult to see, but two knob-like structures interpreted as partly protruded tentacles are present in each of three specimens. No basal papillae are evident.

Bucephalus gorgon (Linton, 1905) Eckmann, 1932

Host: Seriola zonata
Site: Ceca
Locality: Mouth of Pensacola Bay

Our three specimens are referred to this species on the basis of Corkum's (1967) description. At least 19 retracted tentacles can be counted.

Bucephalus varicus Manter, 1940

Host: Caranx hippos
Site: Intestine
Locality: Santa Rosa Island

Family Cryptogonimidae Ciurea, 1933

Siphodera vinaledwardsii (Linton, 1901) Linton, 1910

Synonym: Monostomum vinaledwardsii Linton, 1901

*Host: *Bairdiella chrysura*
Site: Ceca
Locality: Pensacola Bay

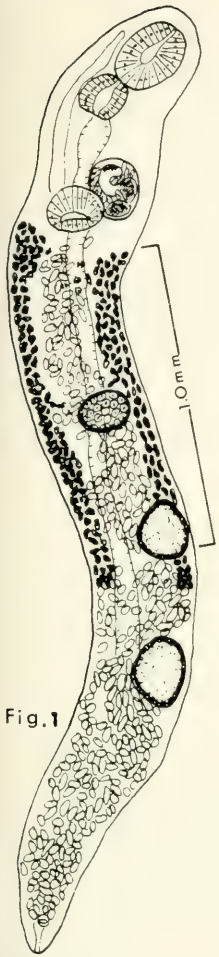
Family Fellodistomatidae Nicoll, 1913

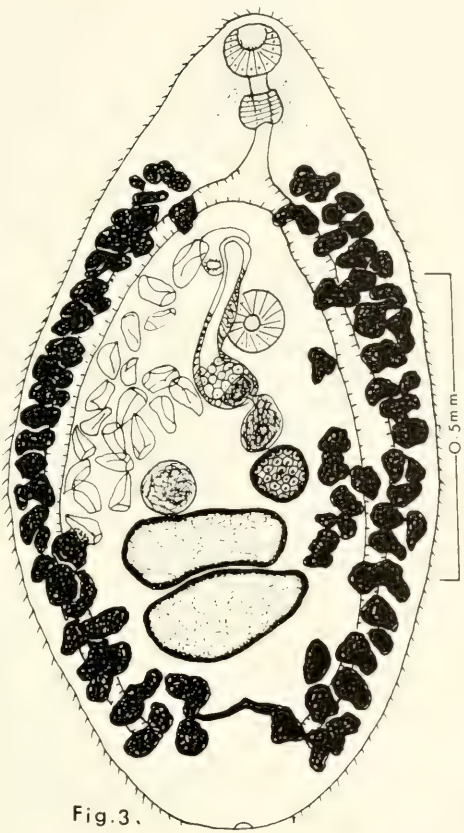
Monascus filiformis (Rudolphi, 1819) Looss, 1907
Figure 1

Synonyms: Distoma filiforme Rudolphi, 1819
Haplocladus filiformis (Rudolphi, 1819) Odhner, 1911

*Host: *Decapterus punctatus*
Site: Intestine
Locality: Santa Rosa Island

Description (based on a single specimen): Body elongate, 3.268 long by 0.408 wide at anterior fourth. Forebody 0.684 long; hindbody 2.414 long. Tegument smooth. Eyespot pigment absent. Oral sucker subterminal, 0.231 long by 0.176 wide. Prepharynx absent. Pharynx cylindrical, 0.132 long by 0.110 wide. Cecum single, extending to near posterior end of body. Acetabulum at ante-





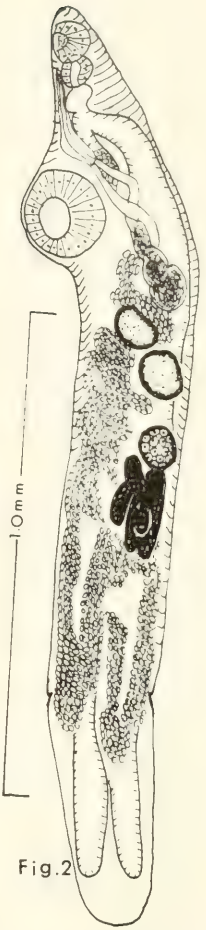


Figure 1. *Monascus filiformis* from *Decapterus punctatus*; ventral view. Figure 2. *Ectenurus yamagutii*, holotype, from *Caranx hippos*; ventrolateral view. Figure 3. *Lepocreadium sogandaresi*, holotype, from *Eupomacentrus leucostictus*; dorsal view.

rior fourth of body, 0.170 long by 0.190 wide; sucker ratio 1:0.9.

Genital pore and atrium submedial, about one third distance between acetabulum and pharynx. Testes two, smooth in outline; anterior testis 0.952 from posterior border of acetabulum, 0.176 by 0.154; posterior testis 1.360 from acetabulum, 0.220 by 0.154. Cirrus sac sinistral, extending from midacetabular level to genital atrium, 0.198 long by 0.143 wide, containing a bipartite seminal vesicle, short pars prostatica and globular cirrus. Ovary pretesticular, separated from anterior testis by uterine coils, smooth in outline, 0.132 long by 0.176 wide. Seminal receptacle not evident. Uterus extending to posterior end of body, coursing anteriorly to insert into genital atrium. Eggs yellowish, 38–43 by 20–26 microns. Vitelline follicles small, numerous, in lateral fields extending from posterior level of acetabulum to nearly midway between testes. Excretory pore terminal; excretory vesicle and its connection with cecum not evident due to overlapping uterus; excretory arms extending laterally, right arm seen reaching level of oral sucker.

This species was previously known from Mediterranean waters only. For this reason, a description and drawing of the present specimen is given.

The status of this genus and its species has been reviewed by a number of investigators including Dollfus (1947), and more recently Fischthal and Kuntz (1963), and Fischthal and Thomas (1968). Most troublesome has been the separation of *Monascus typicus* (Odhner, 1911) Looss, 1912 from the type species *M. filiformis* (Rudolphi, 1819) Looss, 1907. Three features have been used: position of the testes in the hindbody, size of eggs, and their color. According to Dollfus (1947), Odhner distinguished his *Haplocladus filiformis* from *H. typicus* by its more anterior testes (anterior to middle of hindbody) and the somewhat smaller eggs (34–37 microns long) with a reddish brown color. In *H. typicus*, the testes are in, or posterior to, midhindbody and the eggs larger (40 by 24 μ) and yellowish brown in color. On this basis our single specimen should be considered *M. typicus*. It is, however, very similar (except for less elongated pharynx) to Dollfus' specimens of *M. filiformis* from the type host, *Cepola rubescens*. Dollfus (1947) describes in detail the changes that occur in topography of the gonads with maturity of the worms, and indicates the presence of overlapping features between the two species. Fischthal and Kuntz (1963) and Fischthal and Thomas (1968) also note extensive variations in their specimens of *M. typicus*.

If there are any differences between *M. filiformis* and *M. typicus*, they have to be sought in features other than gonad topography and egg size. It is quite possible that *M. typicus* is not a valid species, but the authors hesitate to reduce it to synonymy on the basis of a single specimen.

FAMILY HEMIURIDAE Lühe, 1901

Parahemiurus merus (Linton, 1910) Woolcock, 1935

Synonyms: *Hemiurus merus* (Linton, 1910)
Parahemiurus parahemiurus Vaz & Pereira
P. platichthyi Lloyd, 1938
P. atherinae Yamaguti, 1938
P. harengulae Yamaguti, 1938
P. noblei King, 1962

Host: *Caranx crysos*
Site: Stomach
Locality: Pensacola Bay

Lecithochirium parvum Manter, 1947

Synonyms: *Sterrhurus floridanus* Manter, 1934, in part
Brachyphallus parvus (Manter, 1934) Skrjabin & Guschanskaja, 1955

Host: *Diplectrum formosum*
Site: Stomach
Locality: Pensacola Bay

Lecithochirium synodi Manter, 1931

Host: *Synodus foetens*
Site: Stomach
Locality: Pensacola Bay

Lecithochirium mecosaccum Manter, 1947

Host: *Synodus foetens*
Site: Stomach
Locality: Pensacola Bay

Lecithochirium microstomum Chandler, 1935

Synonyms: *Sterrhurus monticelli* (Linton, 1898) of Manter, 1931, in part
Lecithochirium sinaloense Bravo-Hollis, 1956

Host: *Trichiurus lepturus*
Site: Stomach
Locality: Pensacola Bay

Sterrhurus musculus Looss, 1907

Synonyms: *Sterrhurus laeve* (Linton, 1898) of Manter, 1931, in part
Sterrhurus floridensis Manter, 1934, in part
Brachyphallus musculus (Looss, 1907) Skrjabin and Guschanskaja, 1955

Hosts: *Centropristis melanus*, **Lepophidium profundorum*, **Lutjanus blackfordi*, *Ogcocephalus radiatus*, *Opsanus beta* and *Porichthys porosissimus*

Site: Stomach
Locality: Santa Rosa Island

Lecithocladium excisum (Rudolphi, 1819) Lühe, 1901

Synonyms: *Lecithocladium excisiforme* Cohn, 1903
L. gulosum (Linton, 1899) Linton, 1940
L. cristatum (Rudolphi, 1819) Looss, 1907

L. crenatum (Molin, 1859) Looss, 1907

Host: **Poronotus burti*
Site: Stomach
Locality: Pensacola Bay

Our two mature specimens are considered *Lecithocladium excisum* even though the two suckers are almost equal in size. Except for this feature, they are very similar to *L. gulosum* (Linton, 1899) Linton, 1940 from *Poronotus triacanthus* in Woods Hole, Massachusetts, which is reported by Manter (1954) as a synonym of *L. excisum.* In Linton's specimens, the oral sucker is slightly larger with a ratio calculated to be about 1:0.9. Nahhas and Short (1965) also reported this species from *P. triacanthus* and *Peprilus alepidotus* from Apalachee Bay. In these specimens, the oral sucker is also slightly larger than the acetabulum. In all other features, the Pensacola Bay material is almost identical with those of Apalachee Bay and Woods Hole.

Ectenurus virgulus Linton 1910

Host: Caranx crysos
Site: Stomach
Locality: Pensacola Bay

Ectenurus **yamagutii** new species
Figure 2

Hosts: Caranx crysos, C. hippos, and *Lagodon rhomboides*
Site: Stomach
Localities: Pensacola Bay; Santa Rosa Island
Holotype: U.S.N.M. Helm. No. 70734

Description (based on 10 specimens): Body appendiculate; soma 0.770–1.560 long, 0.209–0.286 wide at level of ovary; ecsoma 0.220–0.484 long, 0.204–0.253 wide. Tegumental plications encircle body anteriorly, extending from anterior end of body to posterior end of middle third of soma ventrally and almost to posterior end of soma dorsally. Oral sucker 0.055–0.075 in diameter, surmounted by a preoral lobe. Prepharynx absent. Pharynx 0.038–0.045 long by 0.045–0.050 wide. Esophagus about as long as pharynx. Ceca extending to near posterior end of ecsoma. Acetabulum at anterior third of soma, 0.135–0.187 in diameter; sucker ratio 1:2.45–2.80.

Genital pore ventral, at anterior level of pharynx. Sinus sac long, well-developed, extending down to anterior level of acetabulum; hermaphroditic duct well-developed with muscular wall, free in sinus sac. Testes in middle third of body, diagonal, smooth in outline, 0.088–0.110 in diameter. Seminal vesicle tripartite, posterior to posterodorsal to acetabulum. Prostatic duct with conspicuous prostatic cells around distal third or half, entering posterior end of sinus sac. Ovary, posttesticular, smooth in outline, 0.063–0.100 in diameter. Uterus entering ecsoma or not, joining prostatic duct at base of sinus sac. Eggs 17–20 by 7–10 microns. Vitellaria immediately postovarian, in two groups of four and three digitiform lobes; lobe length 2–4 times width. Excretory arms not uniting anterior to oral sucker.

The single most important characteristic of this species which distinguishes it from others in the genus is the short digitiform vitellaria. In this feature, *Ectenurus yamagutii* differs not only from other ectenurids, but perhaps from all other members of the subfamily Dinurinae. On this basis, a separate genus may be justified, but because of its strong resemblance in other ectenurid features we prefer to retain it in *Ectenurus.*

This species is named in honor of Dr. Satyu Yamaguti in recognition of his contributions to helminthology.

FAMILY LEPOCREADIIDA Nicoll, 1934

Apocreadium balistis Manter, 1947

Host: Balistes capriscus
Site: Intestine
Locality: Santa Rosa Island

Neoapocreadium coili (Sogandares-Bernal, 1959) Siddiqi and Cable, 1960

Synonym: Apocreadium coili Sogandares-Bernal, 1959

Host: Balistes capriscus
Site: Intestine
Locality: Santa Rosa Island

Except for larger size (4.116–4.320 by 0.992–1.120), the three specimens are in agreement with the description by Sogandares-Bernal (1959). This species is now known from Bimini, Puerto Rico, Jamaica, Biscayne Bay, and Pensacola Bay.

Diploproctodaeum plicitum (Linton, 1928) Sogandares-Bernal & Hutton, 1958

Synonyms: *Distomum* sp. Linton, 1898
Distomum sp. Linton, 1905
Psilostomum plicitum Linton, 1928
Bianium concavum Stunkard, 1930
B. plicitum (Linton, 1898) Stunkard, 1931
B. adplicitum Manter, 1940

Host: Chilomycterus schoepfi
Site: Intestine
Localities: Santa Rosa Island; Santa Rosa Sound

Lepocreadium trulla (Linton, 1907) Linton, 1910

Synonym: Distomum trulla Linton 1907

*Host: *Lutjanus blackfordi*
Site: Intestine

Localities: Santa Rosa Island; Pensacola Bay

Lepocreadium ***sogandaresi*** new species
Figure 3

Host: Eupomacentrus leucostictus
Site: Intestine
Locality: Panama City, Florida
Holotype: U.S.N.M. Helm. No. 70735

Description (based on five specimens): Body, ovoid to pyriform, 0.765–1.360 long, 0.486–0.714 in greatest width at level of ovary. Entire tegument spinose. Eyespot pigment present. Oral sucker 0.055–0.085 long, 0.072–0.100 wide. Prepharynx 0.036–0.045 long. Pharynx 0.036–0.045 long, 0.045–0.063 wide. Esophagus about as long as pharynx. Cecal bifurcation midway between suckers; ceca extending to posterior fifth of body. Acetabulum near anterior and mid-body thirds, 0.070–0.100 in diameter; sucker ratio 1:0.9–1.1.

Genital pore sinistral, midway between acetabulum and cecal bifurcation. Genital atrium large. Testes in posterior half of body, two, tandem, contiguous, 0.090–0.117 long, 0.180–0.279 wide. External seminal vesicle globular to saccular; cirrus sac about ⅓ body length, dextral to acetabulum in 3 specimens and sinistral in 2, extending posteriorly halfway to ovary and containing seminal vesicle in posterior third of sac, globular pars prostatica and a long cirrus. Ovary anterodextral to testes, smooth in outline, globular to slightly irregular in shape, 0.063–0.090 in diameter. Seminal receptacle sinistral to, and level with, ovary. Uterus chiefly anterosinistral to testes, short, containing 15–23 eggs 54–60 by 26–36 microns. Vitelline follicles in two lateral rows extending from level of cecal bifurcation to posterior end of ceca. Excretory pore terminal at posterior end of body; vesicle tubular, extending to level of cecal bifurcation.

These specimens agree with the characters of *Lepocreadium bravoae* Lamothe, 1965 in Edwards and Nahhas' (1968) key to the genus. They differ from that species, however, in having a longer esophagus, less extensive vitellaria, especially in the posterior part of the body, somewhat smaller eggs (54–60 × 26–36 compared with 64–72 × 32–40 μ), and more anterior position of the genital pore.

Lepocreadium sogandaresi also bears some resemblance to *L. floridanus* Sogandares-Bernal and Hutton, 1959 and *L. opsanusi* Sogandares-Bernal and Hutton, 1960. It may be distinguished from the former chiefly by having an entire rather than lobed ovary, unlobed testes and the presence of a larger number of eggs in the uterus (15–23 compared with 2–5). *L. opsanusi* was described provisionally by Sogandares-Bernal and Hutton (1960) from *Opsanus beta.* Nahhas and Cable (1964) reported what they considered the same species, but smaller with smaller and fewer eggs, from *Calamus arctifrons* and *C. bajanado* in Jamaica. *L. sogandaresi* differs from *L. opsanusi* in its larger size, less anterior extent of vitellaria, tandem rather than oblique testes, sinistral rather than dextral position of the seminal receptacle, and ovary not contiguous with right cecum.

This species is named in honor of Dr. Franklin Sogandares-Bernal in recognition of his contributions to helminthology.

FAMILY MONORCHIIDAE Odhner, 1911

Lasiotocus lintoni (Manter, 1931) Thomas, 1959

Synonyms: *Proctotrema lintoni* Manter, 1931
Genolopa lintoni (Manter, 1931) Hopkins, 1941

Host: Orthopristis chrysopterus
Site: Intestine
Locality: Santa Rosa Island

Diplomonorchis leiostomi Hopkins, 1941

Synonym: Diplomonorchis micropogoni Nahhas and Cable, 1964

*Hosts: *Chasmodes saburrae, *Gobiosoma robustum, Leiostomus xanthurus, Micropogon undulatus* and *Monacanthus hispidus*
Site: Ceca and Intestine
Localities: Pensacola Bay; Santa Rosa Sound

The differences in size and shell thickness of eggs of worms taken from the various hosts are striking. The eggs are thick-shelled in specimens obtained from *Monacanthus hispidus* and *Chasmodes saburrae* but thin-walled in those from other hosts. Egg measurements are as follows: from *Chasmodes saburrae* (30–33 × 17–27 μ); *Gobiosoma robustum* (28–32 × 18–22 μ); *Leiostomus xanthurus* (20–30 × 14–20 μ); *Micropogon undulatus* (22–25 × 14–16 μ); *Monacanthus hispidus* (28–38 × 17–24 μ). Since these measurements overlap, and in the absence of other differences, it was decided to consider them all *D. leiostomi.*

Nahhas and Cable (1964) described four new species of *Diplomonorchis*, including *D. micropogoni*, from *Micropogon furnieri* and *Archosargus unimaculatus.* This species was distinguished from *D. leiostomi* by shorter ceca and extent of the uterus, features that vary with body contraction and degree of congestion of uterus, as evidenced in the present material. Overstreet (1969) observed similar variations and considered *D. micropogoni* Nahhas and Cable, 1964 a synonym.

Diplomonorchis floridensis Nahhas and Powell, 1965

Host: Symphurus plagiusa
Site: Intestine
Locality: Pensacola Bay

The presence of spines in the anterior portion of the pharynx and ceca distinguishes this species from others in the genus. Two specimens, one mature, the other immature, show these spines.

Chrisomon sp.

Host: Decapterus punctatus
Site: Intestine
Locality: Santa Rosa Island

Two specimens were recovered, but one was lost during processing. The characteristic features of this monorchiid genus include the large single testis that occupies a large portion of the hindbody, the irregularly lobed ovary, long esophagus and extensive vitellaria, characteristics shown in our remaining immature specimen. Two species are known in the genus: *C. tropicus* (Manter, 1940) Manter and Pritchard, 1961, from *Selar crumenophthalmus* in the Panama Pacific and *C. decapteri* Nahhas and Cable, 1964, from *Decapterus macarellus* in Curaçao, West Indies. The morphology and general topography of organs of our single immature specimen, as well as the presence in a related host, suggest that it is *C. decapteri.*

FAMILY OPECOELIDAE Ozaki, 1925

Opecoeloides fimbriatus (Linton, 1934) Sogandares-Bernal and Hutton, 1959

Synonym: Cymbephallus fimbriatus Linton, 1934

Host: Menticirrhus americanus
Site: Intestine
Locality: Pensacola Bay

FAMILY PLEORCHIIDAE Poche, 1926

Pleorchis americanus Lühe, 1906

Synonyms: Distomum polyorchis Linton, 1901 nec Stossich, 1888
Distoma molle (Leidy, 1856) Stiles and Hassal, 1894
Pleorchis mollis (Leidy, 1856) Stiles, 1896
P. lintoni Yamaguti, 1938
Polyorchis molle (Leidy, 1856) Monticelli, 1896

Hosts: Cynoscion arenarius and *C. nebulosus*
Site: Intestine
Locality: Santa Rosa Sound

FAMILY ZOOGONIDAE Odhner, 1911

Diphtherostomum anisotremi Nahhas and Cable, 1964

Host: Lactophrys quadricornis

Site: Intestine
Locality: Santa Rosa Sound

Alphabetical Host-Parasite List

Bairdiella chrysura (Lacépède), silver perch
Siphodera vinaledwardsii

Balistes capriscus Gmelin, gray triggerfish
Apocreadium balistis
Neoapocreadium coili

Caranx crysos (Mitchill), blue runner
Ectenurus virgulus
Ectenurus yamagutii
Parahemiurus merus

Caranx hippos (Linnaeus), crevalle jack
Bucephalus varicus
Stephanostomum megacephalum
Ectenurus yamagutii

Centropristis melanus Ginsburg, southern sea bass
Sterrhurus musculus

Chasmodes saburrae Jordan and Gilbert, Florida blenny
Diplomonorchis leiostomi

Chilomycterus schoepfi (Walbaum), striped burrfish
Diploproctodaeum plicitum

Cynoscion arenarius Ginsburg, sand seatrout
Pleorchis americanus

Cynoscion nebulosus (Cuvier), spotted seatrout
Pleorchis americanus

Decapterus punctatus (Agassiz), round scad
Monascus filiformis
Chrisomon sp.

Diplectrum formosum (Linnaeus), sand perch
Lecithochirium parvum

Eupomacentrus leucostictus (Müller and Troschel), Beaugregory
Lepocreadium sogandaresi

Gobiosoma robustum Ginsburg, code goby
Diplomonorchis leiostomi

Lactophrys quadricornis (Linnaeus), cowfish
Diphtherostomum anisotremi

Lagodon rhomboides (Linnaeus), pinfish
Ectenurus yamagutii

Leiostomus xanthurus Lacépède, spot
Diplomonorchis leiostomi

Lepophidium profundorum (Gill), cuskeel
Sterrhurus musculus

Lutjanus blackfordi Goode and Bean, red snapper
Lepocreadium trulla
Sterrhurus musculus

Menticirrhus americanus (Linnaeus), southern kingfish
Opecoeloides fimbriatus

Micropogon undulatus (Linnaeus), Atlantic croaker
Diplomonorchis leiostomi

Monacanthus hispidus (Linnaeus), planehead filefish
Diplomonorchis leiostomi

Mycteroperca microlepis (Goode and Bean), gag
immature hemiurids

Ogcocephalus radiatus (Mitchill), polka-dot batfish
Sterrhurus musculus

Opisthognathus fasciatus Longley, banded jawfish
trematode lost

Opsanus beta (Goode and Bean), Gulf toadfish
Sterrhurus musculus

Orthopristis chrysopterus (Linnaeus), pigfish
Lasiotocus lintoni

Porichthys porosissimus (Cuvier), Atlantic midshipman
Sterrhurus musculus

Poronotus burti (Fowler), Gulf butterfish
Lecithocladium excisum

Seriola zonata (Mitchill), banded rudderfish
Bucephalus gorgon

Symphurus plagiusa (Linnaeus), blackcheek tonguefish
Diplomonorchis floridanus

Synodus foetens (Linnaeus), inshore lizardfish
Lecithochirium synodi
L. mecosaccum

Trichiurus lepturus Linnaeus, Atlantic cutlassfish
Bucephalus brevitentaculatus
Lecithochirium microstomum

List of Fishes Negative for Digenea

The number in parentheses represents number of individuals examined.

Ancylopsetta quadrocellata Gill (1), ocellated flounder

Antennarius ocellatus (Bloch and Schneider) (1) ocellated frogfish

Astroscopus y-graecum (Cuvier and Valenciennes) (1), southern stargazer

Elops saurus Linnaeus (1), ladyfish

Equetus acuminatus (Bloch and Schneider) (3), cubbyu

Euthynnus alletteratus (Rafinesque) (1), little tuna

Halichoeres bivittatus (Bloch) (1), slippery dick

Hypsoblennius hentzi (LeSueur) (1), feather blenny

Paralichthys lethostigma Jordan and Gilbert (2), southern flounder

Prionotus tribulus Cuvier (1), bighead searobin

Rachycentron canadum (Linnaeus) (1), cobia

Rypticus bistrispinus (Mitchill) (1), soapfish

Scomberomorus maculatus (Mitchill) (1), Spanish mackerel

Serranellus subligarius (Cope) (2), belted sandfish

Strongylura marina (Walbaum) (1), Atlantic needlefish

Syrictes affine (Gunther) (2), pearlfish

Urophycis floridanus (Bean and Dresel) (1), southern hake

Vomer setapinnis (Mitchill) (1), Atlantic moonfish

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GENERIC KEY AND SYNOPSES FOR FREE-LIVING LARVAE AND TADPOLES OF MEXICAN AMPHIBIANS

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ABSTRACT

A key to the genera of free-living larvae and tadpoles of Mexican amphibians, accompanied by generic synopses and a bibliography, is presented. The salamander key applies to posthatching specimens with front digits fully formed (ca. 20 mm snout–vent length), while the tadpole key applies to premetamorphic and prometamorphic specimens.

Knowledge of Mexican amphibians has increased rapidly during the last 20 years. Although comprehensive reviews can now be made of some groups (e.g., Tihen, 1958; Duellman, 1963; Duellman and Trueb, 1966), investigation of larval forms has lagged. Once larval taxonomy is stabilized, ecological and behavioral studies of the immature forms can be undertaken. The present key and synopses summarize the characteristics of the genera of free-living larval amphibians of Mexico. Data from the literature are combined with new information. Explanation of new terminology and pertinent figures appear in Altig (1970).

Free-living larval salamanders of 19 species in 4 genera and 3 families inhabit Mexico. At least two species, *Siren intermedia* and *Ambystoma dumerilii*, are paedogenetic. In several species of *Ambystoma* and *Rhyacosiredon*, some or all specimens in some populations breed while retaining larval form and external gills; *Ambystoma mexicanum* usually does. Life histories of many other species are poorly known. Although *Taricha* is unknown in Mexico, it is included here because *T. torosa* possibly occurs in Baja California.

Species of *Bolitoglossa*, *Chiropterotriton*, *Lineatriton*, *Parvimolge*, *Pseudoeurycea*, and *Thorius* (Family Plethodontidae), comprising over two-thirds of the Mexican salamander fauna, have terrestrial eggs and direct development; gills and other larval features are lost before hatching.

Free-living tadpoles of 127 species in 21 genera and 8 families inhabit Mexico. Over half of the species are hylids, with the majority of the remainder being bufonids and ranids. All the eggs are aquatic, except for those of *Pachymedusa*, *Agalychnis*, *Centrolenella*, and *Leptodactylus*. The first three lay arboreal eggs and the latter lays eggs in a foam nest in a terrestrial burrow; *Physalaemus* has a floating foam nest. Due to the incomplete data on tadpoles, future revision of some couplets is inevitable. About 78% of the tadpoles have some descriptive data available. *Rana*, *Bufo*, and certain groups of hylids need special attention. Species of *Eleutherodactylus*, *Hylactophryne*, *Syrrhophus*, and *Tomodactylus* (Family Leptodactylidae) have terrestrial eggs, direct development, and lack a free-living tadpole.

KEY

1. Salamander larva or paedogenetic or neotenic adult; external gills present; body form similar to transformed adult 2
   Anuran tadpole; external gills absent; body globular 5
2. Costal grooves absent ..... *Notophthalmus* (east coast), *Taricha* (west coast)
   Costal grooves present 3

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3. Fewer than 20 costal grooves 4
   More than 28 costal grooves ..... *Siren*
4. Pond-type larva with tail fin extending as far as front legs to form dorsal body fin, reduced to low ridge in some paedogenetic or neotenic adults ..... *Ambystoma*
   Stream-type larva with tail fin terminating at level of hind limbs, although a low ridge may extend one-half the distance to the head ..... *Rhyacosiredon*
5. Oral disc and labial teeth absent 6
   Oral disc and labial teeth present 9
6. Jaws without keratinized sheaths; spiracle single (ventromedial) or dual (lateral); body depressed 7
   Jaws with keratinized sheaths; spiracle single and sinistral; body globular ..... *Hyla* (part)
7. Spiracles dual and lateral; oral barbels present ..... *Rhinophrynus*
   Spiracle single and ventromedial; oral barbels absent 8
8. Margins of labial flaps smooth; medial borders of labial flaps parallel or divergent ..... *Gastrophryne*
   Margins of labial flaps scalloped or papillate; medial borders of labial flaps convergent ..... *Hypopachus*
9. Anus medial 10
   Anus dextral 16
10. Tooth row formula 2/4 or larger; papillary border with a narrow (< ½ jaw length) dorsal gap or complete; oral disc not emarginate; spiracle well below longitudinal axis 11
    Tooth row formula 2/3; papillary border with a wide (≃ upper jaw length) dorsal gap or with both dorsal and ventral gaps; oral disc emarginate or not; spiracle at or near longitudinal axis 13
11. Eyes lateral; body globular; A-1 long and with a median gap ..... *Phrynohyas*
    Eyes dorsal; body depressed; A-1 short and without a median gap 12
12. Jaws narrow to medium; jaws never cuspate; lower jaw striated; keratinized area on roof of mouth absent; dorsum usually dark brown to black; to 35 mm total length ..... *Scaphiopus*
    Jaws wide; jaws frequently cuspate; lower jaw not striated; frequently a small keratinized area on roof of mouth; dorsum typically lightly pigmented; to 75 mm total length ..... *Spea*
13. Papillary border with a dorsal gap 14
    Papillary border with dorsal and ventral gaps; oral disc emarginate ..... *Bufo* (part)
14. Oral disc distinctly emarginate ..... *Bufo* (part)
    Oral disc not emarginate, or with a slight lateral indentation 15
15. Darkly pigmented; eyes appear oval to round in dorsal view; dorsal fin terminates at body; inhabits lentic water ..... *Leptodactylus*
    Lightly pigmented; eyes appear C-shaped in dorsal view; dorsal fin terminates on tail musculature; inhabits lotic water ..... *Centrolenella*
16. Papillary border complete or with a dorsal gap 17
    Papillary border with dorsal and ventral gaps ..... *Bufo* (part)
17. Oral disc emarginate; papillary border with a dorsal gap; eyes dorsal 18
    Oral disc not emarginate; papillary border complete or with a dorsal gap; eyes dorsal or lateral 20
18. Labial tooth row formula 3/3 or larger ..... *Rana* (part)
    Labial tooth row formula 2/3 or smaller 19
19. Total length 35 mm or less; central Veracruz and eastern Oaxaca ..... *Rana* (part), *Physalaemus*
    Total length over 35 mm; widespread ..... *Rana* (part)
20. Papillary border complete 21
    Papillary border with a dorsal gap 26
21. Tooth row formula larger than 2/2; gut coiled 22
    Tooth row formula 2/2; gut not coiled ..... *Anotheca*
22. Two rows of labial teeth on anterior labium 23
    More than two rows of labial teeth on anterior labium 25
23. Three rows of labial teeth on posterior labium 24

More than three rows of labial teeth on posterior labium ..... *Hyla* (part)

24. Upper jaw cuspate ... *Plectrohyla* (part)
Upper jaw not cuspate ..... *Hyla* (part), *Plectrohyla* (part)

25. Three or four rows of labial teeth on anterior labium ..... *Ptychohyla*
More than four rows of labial teeth on anterior labium ..... *Hyla* (part)

26. Tooth row formula 2/3 or less 27
Tooth row formula larger than 2/3 ..... *Hyla* (part)

27. Tooth row formula 2/2; medial wall of spiracular tube almost entirely free from body; northeastern region ..... *Acris*
Tooth row formula 2/3; medial wall of spiracular tube attached to body 28

28. Spiracle at or near longitudinal axis, definitely sinistral 29
Spiracle well below longitudinal axis, nearly ventromedial ..... *Agalychnis* (east coast), *Pachymedusa* (west coast)

29. Eyes lateral 30
Eyes dorsal ..... *Hyla* (part)

30. P-3 .75 or more times P-1 31
P-3 .70 or less times P-1 ..... *Hyla* (part), *Pseudacris*

31. Marginal papillae uniserial below P-3 32
Marginal papillae biserial below P-3 33

32. Upper jaw with short lateral processes; P-3 longer than upper jaw; tail fin extends to level of spiracle; Yucatan Peninsula plus semiarid areas of coastal Sinaloa and Oaxaca ..... *Triprion*
Upper jaw with long lateral processes; P-3 subequal to upper jaw; tail fin not extending onto body; wet forest of Atlantic drainage from northern Oaxaca to Chiapas ..... *Smilisca* (part)

33. Upper jaw with long lateral processes; widespread in lowlands ..... *Smilisca* (part)
Upper jaw with short lateral processes; arid coastal areas from Sonora to Michoacan ..... *Pternohyla*

Generic Synopses

Siren.—Three gill slits; medial gill rami branched with fimbriae arising from branches; hind legs never present; dorsal fin extends to level of front legs in young or terminates near cloaca on paedogenetic adults; 30–40 costal grooves between front legs and cloacal aperture; margins of jaws lack teeth but bear keratinized sheaths; known in Mexico from northern Tamaulipas; 1 species.

Notophthalmus and *Taricha.*—Four gill slits; gill rami not branched; feet without keel on trailing edge or webbing between digits; hind legs present from early stages; dorsal fin extends to level of front legs; *Notophthalmus* in Gulf Coastal Plain from southern Texas to northern Puebla and Veracruz; 1 species; *Taricha torosa* may occur in northwestern Baja California.

Ambystoma.—Four gill slits; gill rami not branched; feet without keel on trailing edge; hind legs present from early stages; 11–15 costal grooves (counting one in each axilla and groin); dorsal fin extends to level of front legs or reduced in neotenic and paedogenetic adults to a low ridge; widespread from southern edge of Mexican Plateau northward; 13 species. Although *A. dumerilii*, endemic to Lake Patzcuaro, Michoacan, was long placed in a separate genus (*Bathysiredon*), it is considered by Tihen (1958, 1969) to be an *Ambystoma.*

Rhyacosiredon.—Four gill slits; gill rami not branched; hind limbs present from early stages; digits long and flattened; a distinct keel on trailing edge of feet; 11–13 costal grooves; dorsal fin reduced, reaching at most only half the distance to the head; mountain streams at southern edge of Mexican Plateau from Michoacan-Mexico border to the Puebla-Mexico border and south to northern Morelos; 4 species.

Rhinophrynus.—Oral disc and labial teeth absent; jaws without keratinized sheaths; anus medial; eyes lateral; body depressed; spiracles dual and lateral oral barbels present; upper lip without a median notch; external nares present; lowlands from Texas to Oaxaca; 1 species.

Gastrophryne.—Oral disc and labial teeth absent; jaws without keratinized sheaths; anus medial; eyes lateral; body depressed; spiracle single and medioventral; oral barbels

absent; labial flaps without papillae and with medial margins parallel or divergent; external nares absent until late in development; widespread in lowlands; 3 species.

Hypopachus.—Oral disc and labial teeth absent; jaws without keratinized sheaths; anus medial; eyes lateral; body depressed; spiracle single and medioventral; oral barbels absent; labial flaps scalloped or papillate and with medial margins convergent; external nares absent until late in development; widespread in lowlands; 1 species.

Scaphiopus.—Oral disc present and not emarginate; jaws thin to medium with keratinized sheaths; jaws never cuspate; lower jaw striated; keratinized area on roof of mouth absent; anus medial; eyes dorsal; body slightly depressed to globular; spiracle single, sinistral, but below longitudinal axis; labial tooth row formula 2-6(2-6)/3-6(1-3); papillary border complete or with a narrow dorsal gap; darkly pigmented; northern deserts; 1 species.

Spea.—Oral disc present and not emarginate; jaws medium to wide with keratinized sheaths; jaws often cuspate; lower jaw not striated; keratinized area on roof of mouth often present; anus medial; eyes dorsal; body depressed; spiracle single, sinistral, but below longitudinal axis; labial tooth row formula 2-6(3-6)/4-6(2-6); papillary border complete or with a narrow dorsal gap; often lightly pigmented; to southern edge of Mexican Plateau; 3 species.

Bufo.—Oral disc present and emarginate; jaws thin to medium with keratinized sheaths; anus medial or dextral; eyes dorsal; body globular to slightly depressed; labial tooth row formula 2(2)/2-3[1]; papillary border with anterior and posterior gaps; typically darkly pigmented; spiracle single and sinistral, at or near longitudinal axis; widespread; 25 species.

Physalaemus.—Oral disc present and emarginate; jaws medium with keratinized sheaths; anus dextral; eyes dorsal; body globular; labial tooth row formula 2(2)/3; papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral, and near longitudinal axis; central Veracruz through southern Oaxaca; 1 species.

Leptodactylus.—Oral disc present and not emarginate; jaws thin to moderate with keratinized sheaths; anus medial; eyes dorsal; body globular; labial tooth row formula 2[2]/3; papillary border with a wide anterior gap; darkly pigmented; spiracle single, sinistral and near longitudinal axis; widespread in lowlands; 3 species.

Centrolenella.—Oral disc present and not emarginate; jaws thin to medium with keratinized sheaths; anus medial; eyes dorsal and appear C-shaped in dorsal view; body depressed; labial tooth row formula 2(2)/3; papillary border with an anterior gap; lightly pigmented; spiracle single, sinistral and near longitudinal axis; inhabits mountain streams; eastern and southern areas; 1 species.

Rana.—Oral disc present and emarginate; jaws thin to wide with keratinized sheaths; anus dextral; eyes dorsal; body globular to slightly depressed; spiracle single, sinistral and at or near longitudinal axis; labial tooth row formula 1-7(2-7)/2-6[1], commonly 2(2)/3[1]; papillary border with an anterior gap; darkly pigmented; widespread; 15 species.

Acris.—Oral disc present and not emarginate; jaws medium with keratinized sheaths; anus dextral; eyes dorsolateral to dorsal; body slightly depressed; labial tooth row formula 2(2)/2; papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral and near longitudinal axis; tail tip often black and tail musculature often banded dorsally; northeastern area; 1 species.

Agalychnis and *Pachymedusa.*—Oral disc present and slightly emarginate; jaws medium with keratinized sheaths; anus dextral; eyes dorsal; body globular; labial tooth row formula 2(2)/3; papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral and far below longitudinal axis; widespread in lowlands; 2 and 1 species.

Anotheca.—Oral disc present and not emarginate; jaws medium with keratinized sheaths; anus dextral; eyes dorsal; body globular; labial tooth row formula 2(2)/2; papillary border complete; darkly pigmented; spiracle single, sinistral and near longitudinal axis; gut not coiled; Veracruz; 1 species.

Hyla and *Pseudacris.*—Oral disc present [The *H. microcephala* group, including four species, (Duellman and Fouquette, 1968) lacks labial teeth, keratinized jaw sheaths, and all or most of the oral disc.] and not emarginate; jaws thin to wide with keratinized sheaths; anus dextral (median in *leu-*

cophyllata group); eyes dorsal or lateral; body globular to depressed; labial tooth row formula 2-7(2,7)/3-10[1], commonly 2(2)/3; papillary border complete or with an anterior gap; darkly or lightly pigmented; spiracle single, sinistral and near longitudinal axis; inhabits lentic and lotic water; widespread; 47 species and 1 species.

Phrynohyas.—Oral disc present and not emarginate; jaws medium with keratinized sheaths; anus median; eyes lateral; body globular; labial tooth row formula 4(1-2,4)/4(1); papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral and near longitudinal axis; widespread; 1 species.

Plectrohyla.—Oral disc present and not emarginate; jaws medium to wide with keratinized sheaths; jaws often cuspate; anus dextral; eyes dorsal; body somewhat depressed; labial tooth row formula 2/3[1]; papillary border complete; darkly pigmented; inhabits mountain streams in southern areas; 5 species.

Pternohyla.—Oral disc present and not emarginate; jaws medium to wide with keratinized sheaths; anus dextral; eyes lateral; body globular; labial tooth row formula 2(2)/3; papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral and near longitudinal axis; northwestern area; 2 species.

Ptychohyla.—Oral disc present and not emarginate; jaws medium to wide with keratinized sheaths; anus dextral; eyes dorsal; body globular; labial tooth row formula 4(1)/6-7(1) or 3(1,3)/3(1); papillary border complete; darkly pigmented; spiracle single, sinistral and near longitudinal axis; widespread in mountain streams of southern half of country; 4 species.

Smilisca.—Oral disc present and not emarginate; jaws medium with keratinized sheaths; anus dextral; eyes dorsal; body globular; labial tooth row formula 2(2)/3; papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral and near longitudinal axis; widespread; 2 species.

Triprion.—Oral disc present and not emarginate; jaws medium with keratinized sheaths; anus dextral; eyes lateral; body globular; labial tooth row formula 2(2)/3; papillary border with an anterior gap; darkly pigmented; spiracle single, sinistral and near longitudinal axis; Yucatan Peninsula plus semiarid coastal regions of Sinaloa to Oaxaca; 3 species.

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NEW OR LITTLE KNOWN SPECIES OF TROPICAL FUNGI

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ABSTRACT

Stereum cupulatum Pat. and S. *spumeum* Burt are excluded from *Stereum*; they are, respectively, an imperfect Fungus and *Peniophora cremea* Bres. An unusual form of *Laxitextum bicolor* (Pers. ex Fr.) Lentz is discussed, and a modified description of *Dichopleuropus spathulatus* Reid is presented. Two new species, *L.* ***sharpiana*** and *Paraphelaria* ***colombiana***, are described. *Stereum crassum* Fr. is transferred to *Lopharia* and given a new name.

Stereum cupulatum

An examination of the type (Duss 212 in FH) shows *S. cupulatum* Pat. (in Duss, Fl. Crypt. Antilles Fr. 223. 1903) to be a lignicolous, cupulate fungus which is minutely hairy, dark brown or blackish, and dully iridescent. The inner spore-bearing surface is dull brown to black and cracked toward the center. The fructification arises from a central point and is once or twice concentrically sulcate. Hyphal walls are golden and thin, and all septa are simple ones. A palisade of clavate terminal cells forms the spore-bearing surface and the hyaline, thin-walled spores are attached by long, needle-like prolongations which frequently remain with the spore. Spores appear to be passively discharged. They are 5–7 × 2–3μ. This fungus is neither *Stereum* nor a member of any of the generic segregates of *Stereum*. It seems very likely that *S. cupulatum* is a fungus imperfectus rather than a Basidiomycete. I have included some free-hand sketches of the species (Fig. 1A).

Stereum spumeum

Burt (Ann. Missouri Bot. Gard. 7:208, 1920) lists *Corticium spumeum* Berk. & Rav. as a synonym *pro parte* which is in the literature as *C. spumeum* Berk. & Rav. (Grevillea 20:13. 1891) where Cooke refers to Berkeley's var. *erimosum* of *C. ochroleucum*, (Grevillea 1:166. 1871) who noted that it was "formerly *spumeum* Berk. & Rev." (an herbarium name?). There is no *C. spumeum* in the Curtis Herbarium at the Farlow Herbarium, but there is a *C. ochroleucum* from South Carolina (Ravenel 1772). It is *C. scutellare* Berk. & Curt. A second specimen, collected by Clinton, on the same sheet as the Ravenel collection, is all *C. scutellare*, as is a third collection from the Ellis Herbarium. In the last packet on the sheet there is a note in Burt's hand relating how *C. spumeum* may be a mistake.

An examination of the type material (A. B. Langlois, E. from St. Martinville, Louisiana) reveals it to be probably *Peniophora cremea* Bres. Other material cited by Burt as *S. spumeum* includes S. H. Burnham 27 in BPI which is *Peniophora filamentosa* (Berk. & Curt.) Burt, Michener 1864 in Curtis Herbarium as *Corticium subgigantium* Berk. and probably that species, Edgerton & Humphrey, collected at Baton Rouge, which is *C. scutellare*, and W. A. & E. L. Murrill 405, 414, 498, 503, and 520 from near Cuernavaca, Mexico. All of the Murrill collections are *Peniophora incarnata* (Pers. ex Fr.) Karst., or close to that species. Their gloeocystidia react faintly to sulfobenzaldehyde. Murrill 413 from the same locality is probably that species also. W. A. and E. L. Murrill 1214 from near Cordoba I interpret as a pale-colored form of *Lopharia crassa* (Lév.) Boid.

Laxitextum bicolor

A collection (N0 7258 from Costa Rica) of *L. bicolor* (Pers. ex Fr.) Lentz (Agric. Monog. 24:19. 1955) has relatively large

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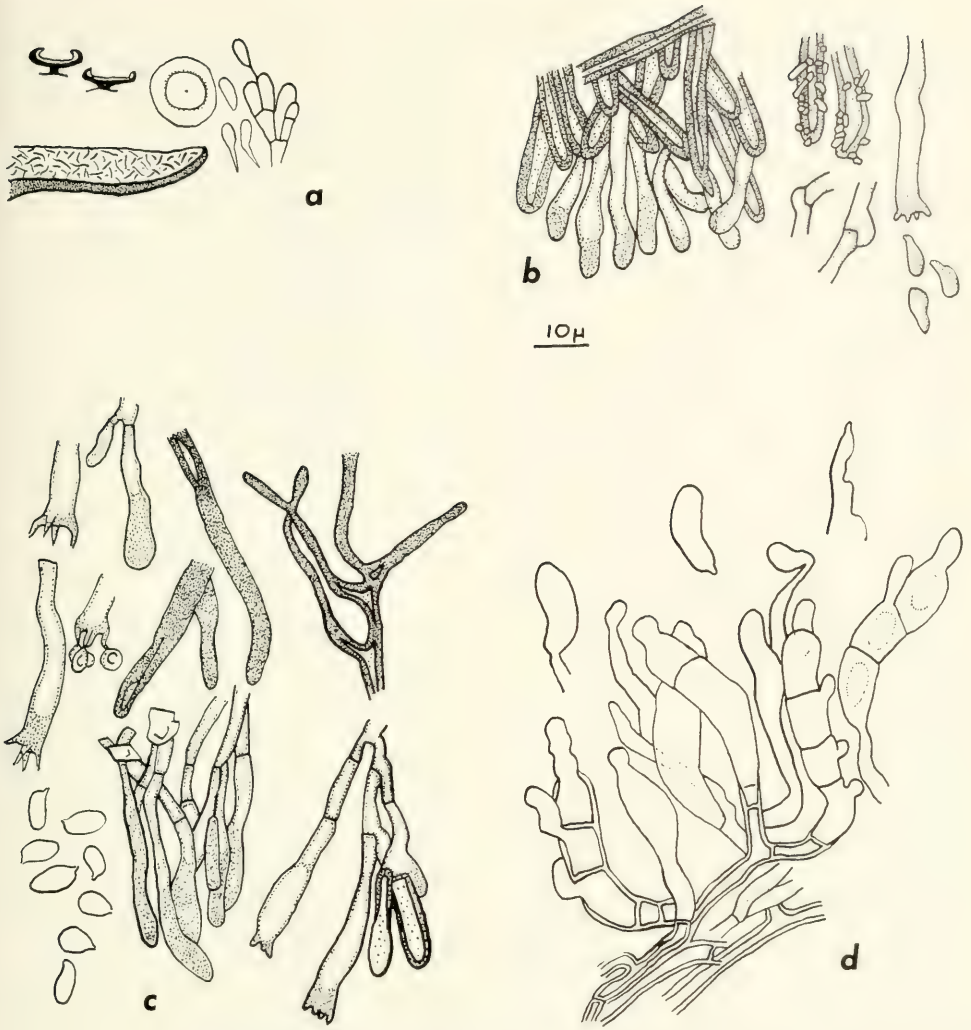

Figure 1. A. Free-hand sketch of *Stereum cupulatum* Pat. showing habit of sporocarps in section and top view and the sporogenous hyphae. B. *Lopharia sharpiana* with hymenial detail, incrusted skeletal hyphae of the hymenium, clamp-bearing hyphae, basidium, and spores. C. *Lopharia mexicana* with young and mature basidia, skeletal and binding hyphae, spores, hymenial detail, basidia and origin of thick-walled, pigmented hyphae at the hymenial level. D. *Paraphelaria colombiana* showing hymenial detail.

basidiocarps and abundant spores, and appears to be in prime mature condition. The collection is unusual and worthy of comment because of its pigmentation. Normally the pilei of this effuso-reflexed species have a dark, tobacco-colored upper surface and a white hymenial surface. The Costa Rican material was completely white when collected and has become a pale tan in the herbarium. There are a few, narrow, darker zones on the upper surface which probably represent rest periods between growth. Upon resoaking the hymenium is waxy and bears a number of warty elevations. The only microscopic distinction is that the spores of this collection are slightly smaller; they measure 3.3–4.7 × 2.4–2.8μ [$\bar{x}$ (10) = 3.8 × 2.7μ], as compared with 3.8–4.7 × 2.4–2.8μ [$\bar{x}$ (10) = 4.5 × 2.7μ] of the typical form, hardly a significant difference. The contextual hyphae

of the Costa Rican form are decidedly paler than the typical form, an expected difference. Additional collections of this form, coupled with cultural studies, may reveal it to be worthy of formal recognition.

Dichopleuropus spathulatus

This fungus was recently described from Malaysian material by Reid (Beih. Nova Hedw. 18:330. 1965). Two collections from Florida have come to hand and represent a considerable range extension. There are a few minor differences between these specimens and the description given by Reid and these are contrasted in the following description by placing Reid's within brackets.

Basidiocarps infundibuliform [spathulate or narrowly flabelliform], about 4 cm tall × 2.5 cm wide [3.15 cm tall and 2.7 cm wide], coriaceous, mesopodal [pleuropodal]; pileus tomentose with tomentum organized into radial, ± knife-like ridges [glabrous, radiately rugulose], zonate with alternating buff and reddish brown zones [. . . pallid, fawn, ochraceous. . . whole surface becoming uniformly ochraceous on drying], tomentum frequently or partially absent in some zones exposing the smooth, deep reddish brown surface, reddish brown tomentum organized into flattened, irregularly toothed elevations at base of pileus; hymenial surface smooth, minutely powdery, bearing scattered, embedded sand crystals, India Buff (12EF),[2] with lighter margin [. . . white becoming pale cream in herbarium material]; central stripe about 2.5 cm tall × 0.8 cm wide at widest part, solid, buff, covered with sand particles [1.7 cm long and 2–3 mm wide, lateral, pallid-fawn-ochraceous. . .].

Generative hyphae 2–3μ diam [1.5–4μ], thin-walled, branching, hyaline, without clamp-connections, frequently collapsed and twisted; dichophysoid hyphae (binding hyphae) with major branches 2–5μ diam, dextrinoid (i.e. turning red in iodine solution), without clamp-connections or septa, walls hyaline to yellow, generally thickened in older ones but with prominent lumina, more profusely branched toward and within the hymenium, scattered throughout the pileus flesh; catahymenial; basidia 8–10μ diam at apex, with four stout, curved sterigmata each up to 7μ long, base not observed but over 48μ long; macrocystidia long-cylindrical, thin-walled, often containing short rod-shaped yellowish elements, of variable length and width, some projecting beyond the hymenial surface, apices blunt or acute, some in the deeper contextual layers and hyphoid; spores 6–9 × 5.5–6.5μ [$\bar{x}$ (20) = 7.5 × 6.0μ], subspherical (e = 1.2), with a thin, smooth, amyloid exosporium and a thin episporium, walls hyaline to pale yellow, contents ± oily and hyaline to pale yellow.

Specimens examined: Fla. Agric. Exp. Sta. Herb. F17924 (Planera Hammock, 21 July 1938, leg. West, Arnold, and Murrill); F18471, Newman's Lake, E. of Gainesville, 30 July 1938, leg. West and Murrill.

Lopharia ***sharpiana***
(Fig. 1B)

Lopharia sharpiana Welden sp. nov. Basidiocarpis effuso-reflexis, glabrosis vel tomentosellis, griseo-roseis (7 A 8 Rose Grey) vel crustulinis (13 E 7 Oakbuff) vel spadiceis (7 A 11 Vandyke Brown); cuticula epicutisque contexto intertexto: hyphis generativis nodososeptatis, hyalinis; hyphis sceletalibus cinnamomeis procurrentibus in hymenio saepe incrustatis. Hab. ad ligna emortua Abietis in Michoacan, Mexico.

Basidiocarpi spongioso-fragiles, effuso-reflexi saepe anastomosantes, solitarii vel complicati, glabrosi vel tomentoselli, in partibus veterioribus griseo-roseis (7 A 8 Rose Grey) vel prope crustulinis (13 E 7 Oakbuff), alteris spadiceis (7 A 11 Vandyke Brown); hymenium laeve, alutaceum vel ochraceum, saepe rimulosum; cuticula epicutisque ex hyphis intertextae cinnamomeis; hyphis generativis 4–5μ diam, nodoso-septatis, hyalinis et hyphis sceletalibus 2–5μ diam cinnamomeis, multis procurrentibus in hymenio et saepe incrustatis; contextus intertextus; basidia 30–43 × 4–5μ, cylindrico-clavata cum 4-sterigmatibus crassis; sporae 5–8.5 × 2.3–4μ [$\bar{x}$ (16) = 6.5 × 2.8μ], apiculatae, laeves, hyalinae, aliquae maturiores brunnescentes inamyloidae.

Typus: Mil Cumbres, E. Morelia, Michoacan, Mexico, 9500 ft. alt., 6.18.1945, leg. A. J. Sharp 3718, in ligno Abietis (in UT 18379 et NO).

[2] Maerz and Paul. Dictionary of Color. Second Edition, McGraw-Hill. 1950.

The presence of clamp-connections, a cuticle, and an interwoven context make this species unique in *Lopharia*. The species is named in honor of its collector, who has made many contributions to botany.

Lopharia ***mexicana***

Lopharia mexicana Welden nom. nov. *Stereum crassum* Fr., Roy. Soc. Sci. Upsal. Actis III. 1:111 1851 non *Lopharia crassa* (Lev.) Boid. Basidiocarpis effuso-reflexis, tomentosis, badiis (8 A 12 Autumn); cuticula nulla, contexto intertexto; hyphis generativibus hyalinis, haud nodoso-septatis; hyphis colligantibus procurrentibus in hymenio. Hab. ad ligno in Mexico.

Basidiocarpus spongiosus, effuso-reflexus, tomentosus, badius (8 A 12 Autumn); margo obtusus, concolor vel pallidior; hymenium laeve, saepe rimulosum, fuscus vel cinnamomeum et margine alutaceo; cuticula nulla, contextus hypharum intertextarum; hyphis generativis 3.8–4.7μ in diam, hyalinis, haud nodososeptatis et hyphis colligantibus 4.7–8.5μ in diam, cinnamomeis, procurrentibus in hymenio et saepe consociatis cum crystallis; basidia 31–38 × 5.7–6.6μ, cylindrico-clavata cum 4-sterigmatibus crassis; sporae 6.6–8.5 × 3.8–4.7μ [$\bar{x}$ (20) = 7.5 × 3.8μ], apiculatae, laeves, hyalinae maturiores brunnescentes inamyloidae.

Typus: Mirador, Mexico, leg. Liebmann in Herb. Fries.

Specimen exemplare: Chilpancingo, Guerrero, Mexico, 6000 ft. alt. 10.20.1944, leg. A. J. Sharp 1015, in lingo Quercus (in UT 16799 et NO).

The interwoven context, the binding hyphae projecting into the subhymenium and hymenium, and the lack of cystidia, a cuticle, and clamp-connections sharply separate *L. mexicana* from other species of *Lopharia*.

Paraphelaria ***colombiana***

(Fig. 1D)

Corner has redescribed *Aphelaria amoinensis* (Lev.) Corner (Persoonia 4: 346. 1966) and transferred it into a new genus of auriculariaceous fungi. Last year I made two collections of a similar fungus in Colombia which appears to differ specifically from *P. amboinensis*.

Paraphelaria colombiana Welden sp. nov. Paraphelariae amboinensi (Lev.) Corner affinis sed receptaculis e subiculo ortis et sporis basidiisque brevioribus et basidiis 2(–3) septis transversis divisis in hymenio. Hab. in bambusa in provinciis Valle Caldasque, Colombia.

Receptaculae subiculo orta ad 3 cm alta, fuliginosus (8 L 12 Mandalay), dense ramosa, inconspicue pilosa, paucis ramis principalibus denuo semel, bis, velter ramulosis, ramis ramulisque depressis, saepe anastomosantibus, apicibus penicillatis; hymenium pallidulum, pulveraceum, sporae 9.5–17.8 × 4.4–6.6μ [$\bar{x}$ (15) = 13.2 × 5.4μ], hyaline, leves, cylindraceae, inamyloideae, tunicis crassis; basidia 26.6–42 × 6.6–8.5μ, 2(–3) septis transversis divisa; hymenium ex hyphis sterilis basidiisque; subhymenium 95–140μ crassum; hyphae 2–4μ diam, hyalinae vel brunneo-ochraceae, septis simplicibus.

Typus: La Palestina in provincia Valle 6.17.68.

Specimen exemplare: Hcnda. Las Alcazares in provincia Caldas 7.3.68.

April 14, 1971

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TULANE STUDIES IN ZOOLOGY AND BOTANY

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HYBOPSIS LINEAPUNCTATA, A NEW CYPRINID FISH FROM THE UPPER ALABAMA RIVER SYSTEM[1]

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and

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ABSTRACT

A new cyprinid, *Hybopsis* ***lineapunctata***, is described from above the Fall Line in the Coosa and Tallapoosa rivers, Mobile drainage. The coarse scales, usually 20–22 around the body, and the dark lateral band are diagnostic characters. *H. lineapunctata* is compared with *Hybopsis amblops* from the Tennessee River, the most closely related form.

Along the inner edge of the Coastal Plain of southeastern United States, the Fall Line marks a distinctive break in geology and biotic distributions. At the Fall Line fast riffles and waterfalls are often effective barriers to fishes, many of which are isolated above the falls, while others are restricted to lowland streams below. Within the headwaters of the Alabama River several endemic fishes have been described, and other forms remain undescribed. One of these, a relative of *Hybopsis amblops* (Rafinesque), has been recognized only recently by Williams (1965: 20), Tucker (1967: 85), and Smith-Vaniz (1968: 40), and is widespread throughout the Coosa and Tallapoosa rivers above the Fall Line.

Numerous other workers have collected this chub (see synonymy), but it has been confused with several related species which inhabit adjacent and nearby streams. A history of the nomenclatural confusion of this group and variation of the related forms are discussed by Clemmer (1971).

Counts and measurements were made according to the methods of Hubbs and Lagler (1958: 19–26) with the following exceptions: the circumferential scale count over the back was taken anterior to the dorsal fin and excluded the lateral line scales. The circumferential scales around the belly were counted immediately anterior to the pelvic insertions and excluded the lateral line scales. The count of predorsal scale rows included rows of scales crossing the midline of the body before the dorsal fin. Vertebral counts taken from x-rays included the Weberian apparatus as four vertebrae.

The postdorsal length extended from the insertion of the dorsal fin to the caudal base. Posterior maxillary length was measured on the right side from the corner of the mouth posterior to the end of the upper jaw. In many individuals the mouth had to be opened with a forceps to obtain this measurement. Most measurements were made on adult specimens of 40 mm standard length or larger; however, gravid females were excluded.

[1] Contribution No. 3 from Laboratory of Systematics and Environmental Biology, Environmental Science Center, Tulane University.

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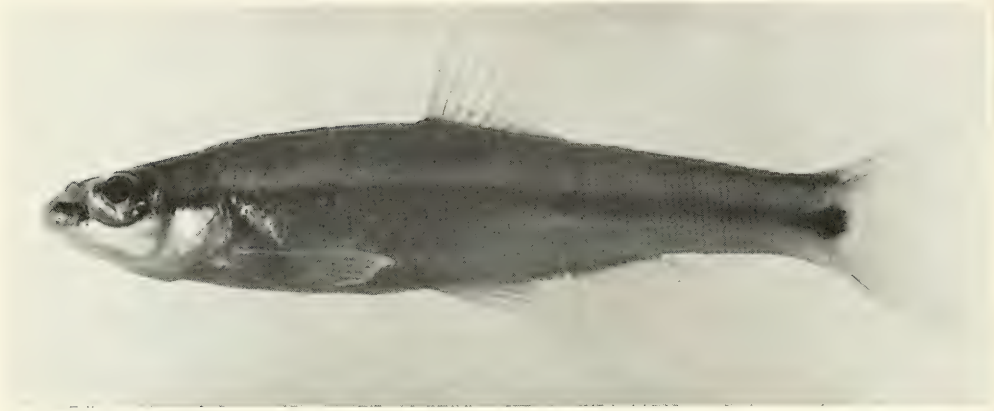

Figure 1. *Hybopsis lineapunctata*, lateral view of a paratype (TU 41118) tuberculate male, 54.5 mm SL, Tallapoosa drainage, Elmore Co., Alabama, 12 April 1966.

Hybopsis **lineapunctata** sp. nov.
Lined chub
(Figs. 1–3)

Nocomis amblops var. *winchelli* (Girard). Jordan, 1877: 328–330 (key, Coosa R.).

Nocomis winchelli (Girard). Jordan, 1877: 330 (Coosa R.).

Nocomis amblops winchelli (Girard). Jordan, 1877: 369 (Etowah R.).

Ceratichthys winchelli (Girard). Jordan and Brayton, 1878: 53 (Coosa R.).

Hybopsis amblops rubrifrons Jordan. Gilbert, 1891: 155 (Coosa R.).

Hybopsis amblops (Rafinesque). Fowler, 1924: 410 (Etowah R.). Boschung, 1961: 270 (Coosa R.).

Erinemus hyalinus (Cope). Fowler, 1945: 341 (Coosa R.).

Hybopsis sp. Williams, 1964: 20 (Tallapoosa R.). Tucker, 1967: 85 (Coosa, Tallapoosa Rivers).

Holotype.—TU 53405, a nuptial male, 61 mm standard length, Tallapoosa River drainage, Clay County, Alabama, Enitachope Creek, tributary to Hillabee Creek, 2.9 miles SW of Ashland, Hwy. 9, RDS 3877, GHC 420, 13 April 1966, R. D. Suttkus and Glenn H. Clemmer.

Collected with the holotype were 46 paratopotypes (TU 40643). Paratypes, all from the Tallapoosa River, and other material examined are listed in a subsequent section. Comparative material of *H. amblops* is listed in Clemmer (1971).

Diagnosis.—A large-sized species of the *Hybopsis amblops* group (maximum length examined, 66 mm in SL) with coarse scales; circumferential scales usually 20–22, sometimes 24 in the Coosa River population. Dark lateral band well developed, narrowing over the caudal peduncle, widening before confluence with a large, darkly pigmented caudal spot. Lateral band accentuated by distinct light band above without melanophores; dorsal scales darkly outlined along their posterior margin.

Description.—Counts and proportional measurements are given in Tables 1–6. *Hybopsis lineapunctata* has a subterete, somewhat compressed body form. The predorsal profile is convex; the postdorsal profile is nearly straight. The head is long, averaging about 27% of standard length. The snout is long and overhangs the inferior, slightly oblique mouth. The lower jaw is included; the single pair of maxillary barbels is well developed. There are eight dorsal fin rays and 12 scales around the caudal peduncle.

The pharyngeal tooth count is 1,4–4,1; the teeth in the main row are compressed and moderately hooked, with tooth IV rounded and nearly straight. The eye is slightly superior (about 28.5% of the head length); the diameter is usually less than the length of the snout.

The lateral line is complete and slightly decurved anteriorly. The anterior scales of the lateral line series are elevated; the exposed portion about twice as high as wide;

TABLE 1. Proportional Measurements of *Hybopsis lineapunctata* and *H. amblops* Expressed in Thousands of Standard Length. (Mean Value in Parentheses).

	lineapunctata		*amblops*
Drainage	Tallapoosa	Coosa	Tennessee
Number of Specimens	50	23	63
S L in mm	42.1–61.7	43.3–54.2	38.0–71.5
Body depth	186–231 (211)	175–224 (197)	185–229 (209)
Body width	111–168 (139)	111–149 (126)	108–161 (134)
Head length	259–283 (260)	261–289 (271)	256–287 (272)
Head depth	145–169 (156)	143–162 (151)	152–171 (161)
Head width	136–160 (147)	130–149 (140)	126–157 (143)
Snout length	68–94 (82)	79–92 (85)	69–93 (82)
Eye length	65–90 (76)	73–87 (80)	74–93 (83)
Interorbital width, bony	49–62 (55)	53–66 (58)	42–56 (50)
Prepectoral length	249–306 (272)	258–287 (275)	247–291 (272)
Prepelvic length	466–526 (499)	476–523 (501)	480–530 (507)
Predorsal length	491–541 (514)	503–535 (518)	506–549 (526)
Preanal length	650–724 (687)	674–722 (695)	668–726 (693)
Caudal peduncle length	203–253 (225)	203–252 (224)	192–237 (216)
Caudal peduncle depth	91–102 (96)	80–100 (94)	82–105 (95)
Dorsal fin base	97–131 (110)	100–118 (111)	107–133 (120)
Dorsal fin length	208–249 (227)	215–252 (230)	212–270 (238)
Anal fin base	78–109 (91)	76–105 (91)	88–118 (102)
Anal fin length	170–228 (188)	167–211 (191)	174–222 (192)
Pectoral fin length	181–230 (211)	191–230 (211)	181–248 (211)
Postdorsal length	482–532 (510)	484–526 (513)	487–528 (511)
Gape width	51–81 (63)	51–67 (60)	56–84 (67)
Posterior maxillary length	26–37 (31)	27–34 (31)	26–36 (31)

the posterior margins are slightly indented. The posterior ⅔ of the breast is scaled.

The dorsal fin originates directly above or just behind the origin of the pelvic fins and is inserted almost equidistant from the snout and caudal base. The dorsal and anal fins are slightly falcate.

Coloration.—In preservation the diagnostic dark lateral band originates anteriorly on the body with a prominent scapular bar. The dorsal edge of the band is even along the entire length; the lower edge is diffuse anteriorly and becomes even-edged about midway along the body. The lateral band underlies a single scale row anteriorly, broadens slightly before the dorsal fin, and narrows to approximately one half the scale depth at the caudal peduncle. The band then widens slightly and is confluent with a large caudal spot. The spot is round to truncate and is slightly larger than the overlying scale. The melanophores generally extend to the

TABLE 2. Comparison of Fin Ray Counts in Two Species of *Hybopsis*.

	Caudal Fin Rays				
Species and Drainage	18	19	20	N	$\bar{x}$
H. amblops					
Tennessee River		97	3	100	19.03
H. lineapunctata					
Coosa River	1	59	1	61	19.00
Tallapoosa River	2	81	1	84	18.99

	Anal Fin Rays				
Species and Drainage	7	8	9	N	$\bar{x}$
H. amblops					
Tennessee River	3	135	3	141	8.00
H. lineapunctata					
Coosa River	5	65	2	72	7.97
Tallapoosa River	26	104	1	129	7.84

base of the caudal rays. Except for a few scattered melanophores, the scales in the lateral line series are transparent. In the diffuse region of the lateral band large melanophores line the scale pockets forming dusky vertical bars that are broken by the lateral line canal.

Immediately dorsal to the dark lateral band is a light band that is one half to one scale deep. Above this band and across the dorsal surface of the body the scales are well outlined with a dark row of melanophores along their posterior margin. The underlying skin is pigmented with a gradual reduction in melanophores anterior to the line of insertion of each scale.

There is a slight to moderately developed mid-dorsal line from the occiput to the dorsal fin which sometimes extends slightly posterior to the dorsal fin.

There are no melanophores below the lateral band except for those which form a weak mid-ventral line extending from the anus to the procurrent rays of the caudal fin.

On the head a dark lateral band extends from the lacrimal region through the eye and across the operculum where it joins the band along the body. An unpigmented area lies just dorsal to the band over the operculum and curves dorsally over the posterior portion of the orbit. The dorsum of the head from the snout to the occipital ridge is darkly pig-

TABLE 3. Comparison of Fin Ray Counts in Two Species of *Hybopsis*.

	Pelvic Fin Rays					
Species and Drainage	6	7	8	9	N	$\bar{x}$
H. amblops						
Tennessee River		2	128	11	141	8.06
H. lineapunctata						
Coosa River			70	2	72	8.03
Tallapoosa River	1	2	133	4	140	8.00

	Left Pectoral Fin Rays						
Species and Drainage	13	14	15	16	17	N	$\bar{x}$
H. amblops							
Tennessee River	1	18	66	48	8	141	15.31
H. lineapunctata							
Coosa River	5	40	24	2		71	14.32
Tallapoosa River	4	60	67	8		139	14.57

TABLE 4. Comparison of Scale Counts in Two Species of *Hybopsis*.

Species and Drainage	Lateral Line Scales 34	35	36	37	38	N	$\bar{x}$
H. amblops							
Tennessee River		19	75	39	5	138	36.22
H. lineapunctata							
Coosa River	1	17	33	16	5	72	36.10
Tallapoosa River	16	68	45	3		132	35.27

Species and Drainage	Predorsal Scale Rows 11	12	13	14	15	N	$\bar{x}$
H. amblops							
Tennessee River		8	48	72	8	136	13.59
H. lineapunctata							
Coosa River	1	11	54	5		71	12.89
Tallapoosa River	1	38	95	5	1	140	12.76

mented with a heavy concentration of melanophores over the orbit and forming a heart-shaped parietal patch.

A few small melanophores are scattered across the snout and encircle the rim of the orbit. The lips and region ventral to the lateral band are unpigmented.

The fins are translucent at the base grading to a distal transparency. Fine rows of melanophores generally outline the rays of the fins except on the innermost rays of the pectoral fins and the entire pelvic fins. The peritoneum is silvery with scattered melanophores.

In life the dorsal half of the body is golden;

TABLE 5. Comparison of Scale Counts in Two Species of *Hybopsis*.

Species and Drainage	Circumferential Scales above Lateral Line 9	10	11	12	N	$\bar{x}$
H. amblops						
Tennessee River	1	6	130	2	139	10.96
H. lineapunctata						
Coosa River	29	13	29		71	10.00
Tallapoosa River	94	18	30		142	9.55

Species and Drainage	Circumferential Scales below Lateral Line 8	9	10	11	12	13	N	$\bar{x}$
H. amblops								
Tennessee River			2	127	4	8	141	11.13
H. lineapunctata								
Coosa River		18	19	32			69	10.20
Tallapoosa River	2	125	11	3			141	9.13

Species and Drainage	Circumferential Body Scales 19	20	21	22	23	24	25	26	27	N	$\bar{x}$
H. amblops											
Tennessee River				1	6	120	6	6	1	140	24.09
H. lineapunctata											
Coosa River		14	13	11	11	22	1			72	22.24
Tallapoosa River	2	87	20	26	3	3				141	20.65

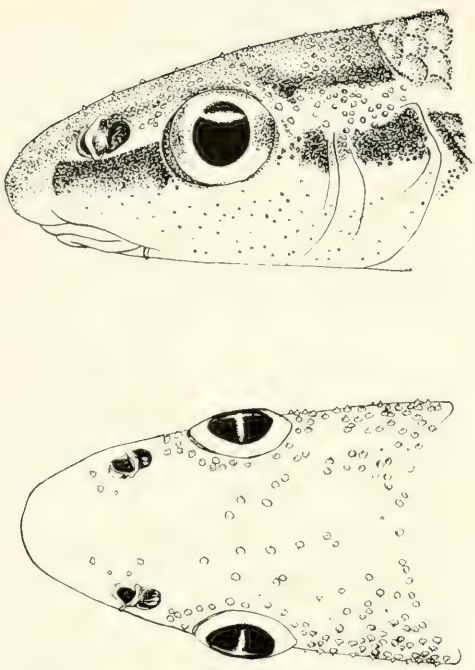

Figure 2. Lateral and dorsal view of head of *Hybopsis lineapunctata* showing characteristic nuptial tuberculation and lateral pigmentation.

the region below the lateral band is silvery white. The iris has a slight orange tint. No breeding colors or sexual dimorphism in pigmentation were noted. The coloration of the juveniles is essentially the same as that in the adults.

Nuptial tubercles are moderately developed on the head and pectoral fins of the male during the breeding season (Fig. 2). Small tubercles are scattered over the dorsal surface of the head extending just anterior to the nostrils. There is a slight concentration of tubercles lining the dorsal rim of the orbit, and a greater concentration covering the area over the operculum dorsal to the pigmented band. Irregular rows of tubercles develop along the margins of the dorsal scales, diminishing in number laterally and toward the dorsal fin. The remainder of the body and head is devoid of tuberculation; however, there are prominent sensory pits and papillae over the lateral and ventral surfaces of the head. These latter structures are also evident on the head of the breeding female.

The first seven or eight pectoral rays of the male are lined with tubercles on the dorsal surface. The first ray has a single row at the base, a double row of tubercles often irregularly arranged medially, with a reduction to a single row along the outer margin of the ray. The second to seventh or eighth rays have a single row of tubercles proximally, two to three rows in patches of six to twelve tubercles per ray joint centrally, diminishing to a single row along the distal portion of these rays.

Reproduction.—Tuberculate males with enlarged testes and females with mature ova were collected from mid-March to early June. Ripe males and females were taken on 12–13 April 1966, in four tributaries of the Tallapoosa River. Stream widths varied from 2 to 45 ft.; the water was clear to moderately turbid. All collections were made during the day with water temperatures varying from 17–21°C; air temperatures were 21–26°C. *H. lineapunctata* was taken over sand and sand-silt bottoms from the deeper pools in the smaller streams and usually from along the banks in slow to quiet water in the larger tributaries having a moderate current. Most of the specimens collected were breeding adults with individuals as small as 34 mm having enlarged gonads. Post-spawning adults were collected as early as 23 May. The males had lost their nuptial tuberculation, and both sexes were emaciated.

Range.—*H. lineapunctata* is endemic to the Tallapoosa and Coosa rivers above the

Table 6. Frequency Distribution of Vertebrae in Two Species of *Hybopsis*.

Species and Drainage	36	37	38	N	$\bar{x}$
H. amblops					
Tennessee River	19	23	2	44	36.61
H. lineapunctata					
Coosa River	16	12	1	29	36.48
Tallapoosa River	21	16	1	38	36.47

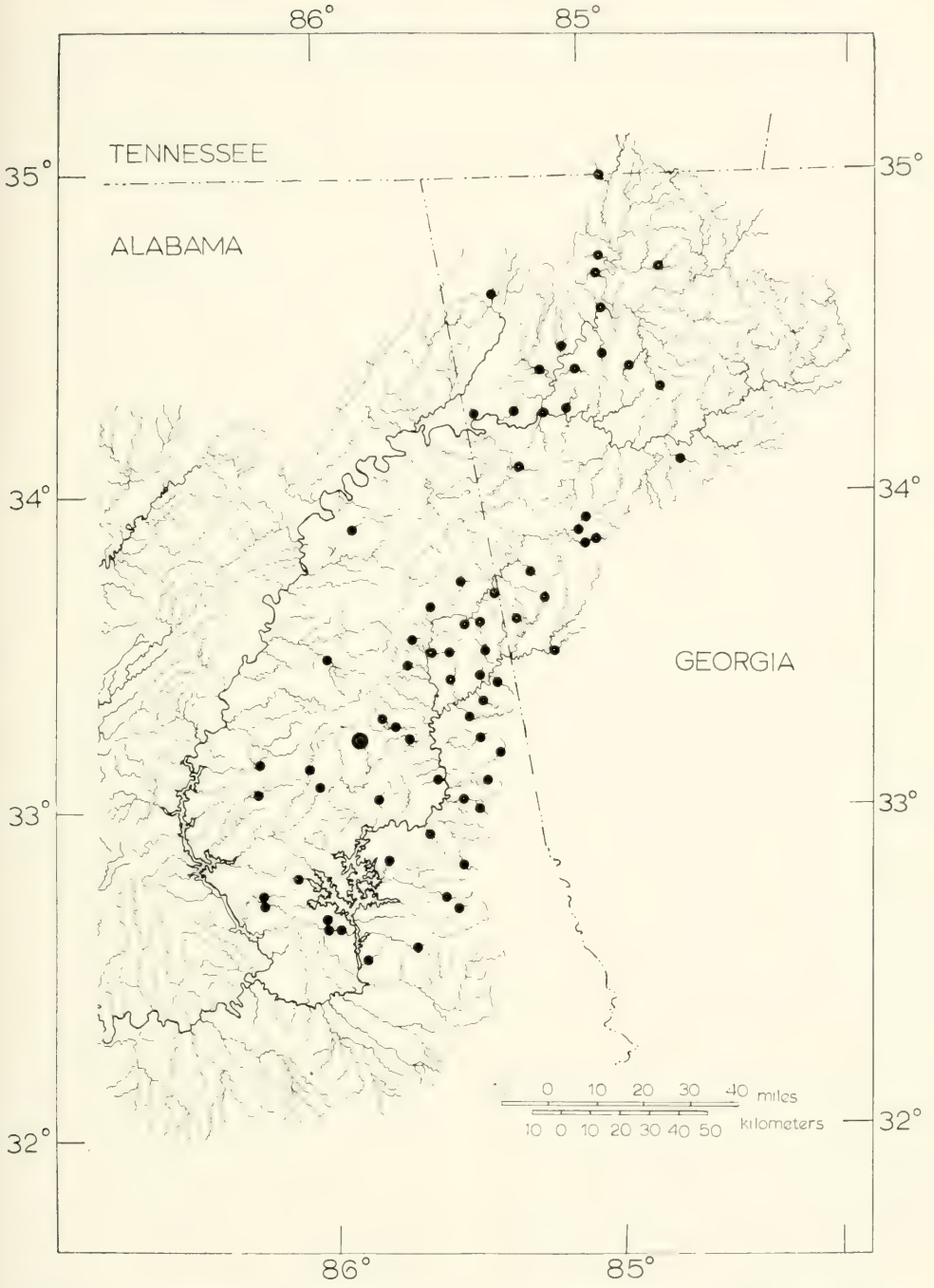

Figure 3. Distribution of collection sites of *Hybopsis lineapunctata* in the upper Alabama River system. Large circle indicates type-locality.

Fall Line in Alabama and Georgia and has been collected in Mill Creek in Tennessee. It is commonly found in small to moderate-sized streams in slightly flowing to quiet water, usually near riffle areas. In recent collections from streams affected by impoundments, *H. lineapunctata* has been absent to rare. It has not been reported from the Tallapoosa and Coosa rivers proper, although the main channels have not been well surveyed. The two specimens reported by Williams (1965) and Tucker (1967) from Uphapee Creek, a tributary of the Tallapoosa River, below the Fall Line were misidentified (Williams, personal communication).

Variation.—The scale size of *H. lineapunctata* is relatively variable as shown in the circumferential body scale counts (Table 5). The Tallapoosa River population usually has coarser scales around the body (19 to 24, usually 20 to 22, $\bar{x}$: 20.65) than does the Coosa River population with scale counts of 20 to 25 (usually 24 or less, $\bar{x}$: 22.24). Most of the higher counts were from specimens collected in the headwaters of the Coosa system in Georgia. This may be attributed to the higher altitude and corresponding environmental factors which may have affected scale size during embryological development. There was no clinal trend in this count on specimens from the Tallapoosa River.

The pharyngeal tooth count for 44 specimens was 1,4–4,1; one had 0,4–4,1, two had 1,4–4,0, and one had 2,4–4,2.

Several specimens lacked barbels. Other counts, coloration, and morphometric characters were relatively uniform.

Relationships.—*Hybopsis lineapunctata* is apparently most closely related to *H. amblops*. The two species are similar in size, general body form, tubercle arrangement, and most meristic and morphometric data. *H. lineapunctata* and *H. rubrifrons* are also morphologically similar. These three forms are considered as a close species group distinct from other *Hybopsis* species from neighboring streams. The red breeding color of *H. rubrifrons* is unique for this group and is considered to be a specialized character. *H. rubrifrons* is probably an isolated derivative, and did not give rise to *H. lineapunctata.* The coarse scales and distinctive lateral pigmentation of *H. lineapunctata* are also unique characters for this group and suggest a modified condition following isolation. These characters along with the isolated distribution suggest that *H. lineapunctata* is a derivative of a *H. amblops* stock.

H. lineapunctata presumably originated from *H. amblops* stock of the Tennessee River which gained access to the Coosa River through stream capture. Campbell (1896) and Hayes (1899) gave geological evidence for stream changes in this area. Ramsey (1966) and Smith-Vaniz (1968) also provided evidence of faunal exchange between these drainages in their comparisons of the ichthyofauna of this region. Following a period of isolation and differentiation within the Coosa River, *H. lineapunctata* later spread into the Tallapoosa River. This dispersal also was probably through stream piracy as the mouths of both rivers lie below the Fall Line. *H. lineapunctata* now occurs above the Fall Line, isolated from other members of the *H. amblops* complex.

Etymology.—The name *lineapunctata* refers to the diagnostic pigmentation of the lateral band and the prominent caudal spot.

Materials.—Other paratypes all from the Tallapoosa system. Georgia—Carroll Co.: UAIC 1310 (2) Turkey Cr., 1 mi NW Mt. Zion Community, 4 July 1964; UAIC 1316 (3) Indian Cr. 3.5 mi ENE Tyus, 5 July 1964; UAIC 1317 (6) Mountain Cr. Hwy 5, 3 mi W Tyus, 5 July 1964; UAIC 1318 (6) Small Creek 5 mi, N Bowden, 5 July 1964; Haralson Co.: UAIC 1251 (2) Wircher Cr. 3.5 mi N Hwy 120, 2.5 mi W jct. 120 and 101, 18 April 1964; UAIC 1308 (1) Walker Cr. Hwy 100, 1.7 mi S Tallapoosa city limits, 4 July 1964; UAIC 1309 (1) Walker Cr. 3.2 mi SW Waco near Carroll Co. line, 4 July 1964.

Alabama—Chambers Co.: UAIC 1375 County Line Cr., 0.7 mi W Ridge Grove or Sikes, 14 August 1964; UAIC 1376 Carlisle Cr. 0.5 mi S Albany, 9 mi N Lafayette, 14 August 1964; UAIC 1377 (6) Caty Cr. 0.7 mi N Johnson's Crossroads, 0.3 mi S Chambers Road, 14 August 1964; UMMZ 168670 (3) Chikasanoxee Cr. at Milltown, 3 September 1954. Clay Co.: UAIC 1036 (10) Crooked Cr., Hwy 48, 2.3 mi S Lineville, 12 September 1963; UAIC 1039 (15) Enitachope Cr., Hwy 9, 2.9 mi SW Ashland, 12 September 1963; UAIC 1509 (2) Trib. to Ketchepedrakee Cr., Hwy 9, 3 mi NNE Delta, 5 November 1964; UAIC 1517 (9) White Oak Cr., 1 mi S Cragford School, 11 November 1964; UMMZ 168767 (1) Hatchet Cr., Hwy 7, 8.3 mi N Good-

water; UMMZ 175795 (2) Hatchet Cr., Hwy 7, 8.3 mi N Goodwater, 13 September 1958; UMMZ 177751 (19) Crooked Cr., 1.5 mi SW Lineville, 23 May 1956; TU 29884 (1) Enitachope Cr., Hwy 9, 2.9 mi SW Ashland, 21 September 1963; TU 32729 (8) Enitachope Cr., Hwy 9, 2.9 mi SW Ashland, 1 June 1964. Cleburne Co.: UAIC 1064 (1) Cahulga Cr., Hwy 78, 0.2 mi W Heflin, 3 November 1963; UAIC 1066 (26) unnamed trib., Hwy 46, 1.7 mi NW Tallapoosa R., 3 November 1963; UAIC 1067 (2) Vero Cr., Hwy 46, 3.2 mi E Tallapoosa R., 3 November 1963; UAIC 1068 (41) Knakes Cr., 2 mi SW Hwy 46 at Hightower, 3 November 1963; UAIC 1069 (2) Lockchelooge Cr., Hwy 431, 0.5 mi E Tallapoosa R., 3 November 1963; UAIC 1098 (13) unnamed trib. to Cane Cr., Hwy 78, 0.2 mi E Edwardsville, 7 December 1963; UAIC 1319 (3) Kelly Cr., 0.5 mi N Lebanon, 5 July 1964; UAIC 1320 (3) Silas Cr., 4 mi S Hopewell, 5 July 1964; UAIC 1504 (3) Lockchelooge Cr., 0.5 mi N Micaville, 5 November 1964; UAIC 1505 (2) unnamed trib. near Randolph Co. line, 7 mi E Micaville, 5 November 1964. Elmore Co.: UAIC 1284 (5) Channahatchee Cr., 2 mi N Kent; UAIC 1362 (4) Channahatchee Cr., 1 mi E Eclectic, 9 August 1964; TU 12085 (8) Gold Branch Hwy 63, 6 mi NE Eclectic, 5 October 1955; TU 15281 (156) Gold Branch, Hwy 63, 6 mi NE Eclectic, 16 March 1957; TU 41118 (28) Gold Branch, Hwy 63, 12 April 1966; TU 41132 (1) Channahatchee Cr., Hwy 229, 2.5 mi S Red Hill, 12 April 1966. Lee Co.: UAIC 1529 (5) unnamed trib. to Sougahatchee Cr., Hwy 11, 0.6 mi SE Macon Hill, 14 November 1964; UAIC 1911 (2) Little Loblockee Cr., Hwy 147, 0.5 mi S Gold Hill. Paulding Co.: UAIC 1247 (3) McClennan Cr., Hwy 101, 1.5 mi N jct. Hwy 120, 18 April 1964; UAIC 1248 (4) unnamed trib. to Wircher Cr., 3 mi N jct. Hwy 100 and 101, 18 April 1964; UAIC 1249 (2) Wircher Cr., 2 mi SW Yorksville, 18 April 1964; UAIC 1250 McClennan Cr., 0.8 mi N off Hwy 120, 2.5 mi W jct 101. Randolph Co.: UAIC 1378 (25) Jones Cr., Hwy 431, 1 mi N Roanoke, 14 August 1964; UAIC 1379 (3) Cornhouse Cr., Hwy 431, 7.0 mi NW Roanoke, 14 August 1964; UAIC 1380 (1) Wedowee Co., Hwy 48, 0.5 mi E Wedowee, 14 August 1964; UAIC 1381 (5) Bear Co., Hwy 48, NE Wedowee, 14 August 1964; UAIC 1382 (7) Cutnose Cr., Hwy 48, NE Wedowee, 14 August 1964; UAIC 1383 (2) Cohobodiah Cr., Hwy 82 at Newall, 14 August 1964; UAIC 1497 (17) Pineywoods Cr., Hwy 341, 11 mi N Wedowee, 31 October 1964; UAIC 1519 (14) Hurricane Cr. between Almond and Malone, 11 November 1964; UMMZ 168762 (5) Wedowee Cr. at Wedowee, 12 September 1954; TU 40668 (12) Trib. to Little Tallapoosa R., Hwy 82, 2.9 mi W Hwy 431, 13 April 1966. Tallapoosa Co.: UAIC 1282 (20) Stone Cr. at Carrville, 0.1 mi N Hwy 14, 14 June 1964; UAIC 1487 (2) Buck Cr., Hwy 280, just E Dadeville; UAIC 1522 (92) County Line Cr. between Hampton and Buttston, 11 November 1964; UAIC 1523 (1) Timbergut Cr., Hwy 22, W New Site, 11 November 1964; CU 51708 (6) Coon Cr., 6 mi N Tallassee, 10 April 1965.

Other material, all from the Coosa drainage:

Tennessee—Bradley Co.: UT 44.330 (2) Mills Cr., NE Red Clay, Ga., 16 November 1968.

Georgia—Bartow Co.: TU 7391 (10) Trib. to Coosawattee R., Hwy 411, 2 mi N White, 19 April 1953; TU 12078 (1) Trib. to Pine Log Cr., Hwy 140, 0.3 mi W Folsom, 9 October 1955. Cherokee Co.: ANSP 75647 (1) N Spring Cr., 6 July 1942; ANSP 75648 (2) Chesterfield Cr., 4 mi S Menla, 10 July 1942; ANSP 75649 (2) Terrapin Cr., 6 July 1942. Cobb Co.: CU 20964 (1) Trib. to Allatoona Cr., Hwy 41, 0.4 mi SE Acworth, 12 June 1952. Floyd Co.: CU 17420 (3) Trib. to Oostanoula R., Hwy 53, 11.7 mi NE Rome, 31 March 1950; UMMZ 88206 (2) Trib. to Coosa R., 5 mi W Coosa, 1 September 1929; UMMZ 88228 (4) Trib. to Coosa R., E Coosa; UMMZ 88252 (8) Armuchee Cr. at Armuchee; UMMZ 157919 (2) Trib., Hwy 411, 5 mi ESE Rome. Gordon Co.: UMMZ 139118 (12) Oostanoula R. at mouth of Spring Branch, 1 mi NE Hwy 41 between Resaca and Calhoun; TU 35039 (1) Trib. to John Cr., Hwy 156, 10.5 mi W Calhoun, 24 June 1964. Murray Co.: CU 24913 (2) Trib. to Coosawattee R., Hwy 411, 5.1 mi S Chatsworth, 4 September 1953; CU 28277 (2) Trib. to Holly Cr., Hwy 411, 3.2 mi S Chatsworth, 4 September 1953; TU 37558 (1) Rock Cr., Hwy 411, 6 mi S Chatsworth, 26 April 1965; USNM 168045 (1) Trib. Hwy 411, 5.2 mi S Chatsworth, 10 September 1954. Polk Co.: UMMZ 88200 (2) Lake Cr., 5 mi NW

Cedartown, Walker Co.: TU 27570 (1) Trib. to Chattooga R., 2.5 mi E of point 8.3 mi S Lafayette, 30 May 1962; TU 40672 (1) Duck Cr., Hwy 337, 1.3 mi NE Centerpost, 14 April 1966; TU 40697 (7) Duck Cr., 0.2 mi E Bronco, 6.8 mi SW Lafayette, 14 April 1966. Whitfield Co.: CU 21207 (4) Trib. to Conasauga R., Hwy 41, 1 mi S Dalton, 13 June 1952; CU 42557 (1) Swamp Cr., Hwy 41, 6.1 mi S Dalton, 20 April 1962; UMMZ 139097 (1) Trib. to Conasauga R., Hwy 41, 7.3 mi S Dalton.

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THE SESSILE STAGES OF A SCYPHOZOAN IDENTIFIED AS *RHOPILEMA VERRILLI*

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ABSTRACT

Medusae of a rhizostome, *Rhopilema verrilli*, have been observed at Solomons, Maryland, in 1965 and 1967. No previous record from Maryland waters was found. The sessile polyp, strobila and cyst stages of this species are described for the first time.

Several scyphozoan coelenterates occur in the Chesapeake Bay. The troublesome summer sea nettle, *Chrysaora quinquecirrha* DeSor, is abundant in the warmer months and is joined by the moon jelly, *Aurelia aurita* L., in late summer and fall. During the colder months, these medusae are absent and the winter jellyfish, *Cyanea capillata* L. appears. The only other species of scyphozoan recorded from the Bay is the rhizostome *Rhopilema verrilli* Fewkes, which was seen on two occasions near the mouth of the Bay in early winter (Wass 1965). There is no record of this species from Maryland waters (Kramp 1961) and the absence of information on its sessile stages has prompted this account.

A large gravid female medusa of 25–30 cm bell diameter was taken from the Patuxent River at Solomons, Maryland on 12 October 1965. It was accompanied by four crabs, two *Libinia dubia* H. Milne Edwards and two *Callinectes sapidus* Rathbun clinging to the sub-umbrella space between the oral arms and the marginal lappets, an association reported previously (Jachowski 1963) for *Aurelia aurita*. It was not identified in the field but was kept in a tank of running river water for several weeks. It then died and was discarded. The short, large, terminal appendages and the brownish color of the mouth arms led me to identify it as *Rhopilema verrilli*.

This species was not seen in 1966, but in 1967 several were taken (up to 15 cm diameter) at Solomons and in nearby waters. Its recent presence in this area has urged me to make this information available despite the loss of the specimen upon which these observations were made.

Pieces of gonad material from the 1965 specimen were placed in aerated bowls and within a few days large numbers of polyps were found on the bottom of the bowls. Other sets of polyps were secured by shaking the medusa in a bowl of water and aerating for 24 hours. Clean bowls were also placed in the aquarium where the medusa was kept and subsequently polyps were found in them, too.

The gonad material developed without any motile planular stage into masses of scyphistomae, grossly enlarged, misshapen and monstrous when compared with scyphistoma of other species. These fed and behaved in a normal fashion (see below), but were not closely observed because of their obvious aberrant development. Glass bowls exposed in the tank where the medusa was kept also accumulated a set of polyps. These polyps were radially symmetrical and had a more characteristic morphological appearance. I could not determine whether the "normal" appearing scyphistome had developed from unnoticed planulae or from small pieces of gonadal material. "Normal" appearing polyps are discussed and described below.

Polyps became identifiable in three to five days after the bowls containing the gonadal material from the adult medusae had been placed in the running water. The tempera-

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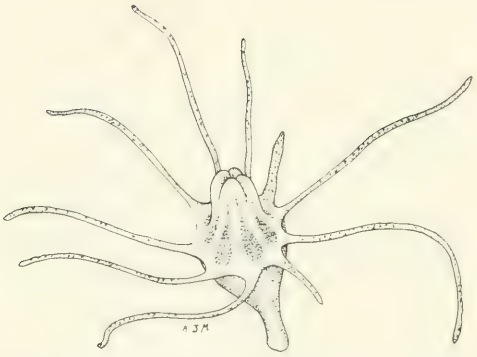

Figure 1. Newly set scyphistoma of *Rhopilema verrilli.*

ture was 18 C. Figure 1 shows the general morphological features. The diameter of the tentacular disc was .35 mm, length of mouth .25 mm, and the polyp height was .75 to 1.0 mm. No peristomial pits were present and the usual number of tentacles was eight or ten.

The polyps reacted negatively to strong light and seemed to sense vibrations in the water, particularly those caused by small zooplankters. Larval barnacles, brine shrimp and a lavender-colored turbellarian were stung and taken by the tentacles of the polyp. The tentacles then quickly thrust the food organism into the open, protruding and flexible mouth. A small white nudibranch, *Tenellia pallida* Alder and Hancock was seen to ingest some of these polyps. It probably ate others as the nudibranch deposited eggs within the bowl and eventually all polyps disappeared from that bowl.

Six months after these polyps had set in the bowls, we attempted to induce strobilation, assuming that they were seasonally similar to *Chrysaora.* The bowls, which had been kept in our running water tanks, were then at 13.5‰ salinity and a temperature of 9 C. They were removed and raised to room temperature of 20 C, aerated, and 1 gm of "Rila Marine Mix" (Rila Products, Teaneck, N.J.) was added each day for six days, to 500 cc of river water, raising the salinity to 19.6‰. Seven days later, two polyps had begun strobilation. One appeared more fully developed than the other (Figure 2). They are characteristic monodisc strobilae and very much like that of *Cassiopea xamachana* Bigelow, as pictured in Mayer (1910), page 642. The ephyrae pulsated strongly; the retractile

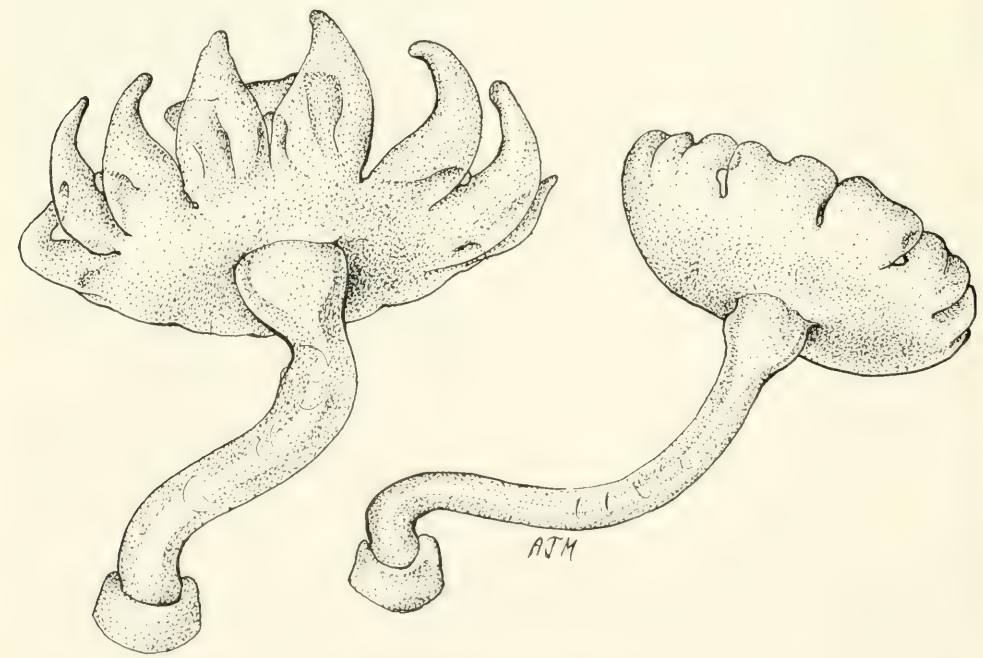

Figure 2. Strobilae of *Rhopilema verrilli* showing pedal cyst. The strobila on the right is the more advanced.

Figure 3. Medusa of *Rhopilema verrilli*. Drawn by A. J. Mansueti after Mayer 1910.

mouth was well developed and flexible. The mouth of *Rhopilema* is not as long in relation to the width of the ephyral disc as is that of *Cassiopea*, nor is the swelling of the stalk as large or as deeply indented where the ephyral disc is attached.

The cell layers of the ephyrae are peach or orange-red in color and the statocysts in the rhopalia (sense organs) are a bright yellow gold and appear birefringent. The lappets, at first somewhat elongate, gradually became shortened and rounded as the separation of the ephyra became imminent.

This species possesses a cyst stage. The cysts, first seen beneath the strobilae and later in bowls not bearing strobilae, are small (.4 mm in diameter) and a golden, pearly white color. The side walls are almost vertical and the tops are nearly flat (Figure 2). The concentric rings typical of scyphozoan cysts are depressed only slightly. The deposition, or manufacture, of these cysts was not

observed, nor were we able to keep them long enough to determine their viability or mode of budding.

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FECUNDITY STUDIES ON THE CRAWFISH *PROCAMBARUS HAYI*

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ABSTRACT

Fecundity studies were conducted on the pond crawfish *Procambarus hayi*, a species with apparent potential for commercial cultivation in northern Mississippi. Total ovarian and abdominal egg counts from adult-size females were utilized. A direct relationship existed between female size and number of eggs produced and laid. Fewer abdominal than ovarian eggs were noted in all size categories and probable reasons for this discrepancy are given. Fecundity of *P. hayi* is judged comparable to that of *P. clarkii* and *P. acutus acutus*, two commercially important species in Louisiana.

INTRODUCTION

Quantitative studies on fecundity of crawfishes are few; most studies utilized total counts of extruded or abdominal eggs (Langlois, 1935; van Deventer, 1937; Tack, 1941). Eggs of crawfishes may become detached from the female pleopods and total abdominal egg counts would not represent the potential fecundity of a species. Ovarian egg counts estimate the gross fecundity and, when used in conjunction with total abdominal egg counts, provide a better estimate of the potential fecundity of a species. Penn (1943), Smith (1953) and Smart (1962) utilized total ovarian egg counts to express reproductive potential in *Procambarus clarkii*, *Faxonella clypeatus*, and *Cambarus longulus longulus* respectively; Prins (1968) combined both types of egg counts in describing the fecundity of *Orconectes rusticus rusticus*.

Fecundity studies were conducted on the crawfish *Procambarus hayi* (Faxon) from two ponds in the vicinity of State College, Mississippi. This species, which reaches large population sizes in shallow farm ponds in the northern portion of Mississippi, has apparent potential for commercial cultivation. *P. hayi* compares favorably in size with *P. clarkii* and *P. acutus acutus* (= *P. blandingii acutus*), the two principal species of commercial importance in Louisiana. Various aspects of crawfish cultivation in Louisiana are noted by Viosca (1961), LaCaze (1966), Avault et al. (1970) and Ham (1971). Cultivation of *P. hayi* would provide crawfish specimens for human consumption, for bait and for use in biological investigations. The reproductive capacity of this species, herein reported, would be important in determining what quantity could be removed prudently from a given locality.

THE REPRODUCTIVE CYCLE

During September and October females of *P. hayi* oviposited within burrows near pond margins; after hatching, juveniles of 4.3 to 4.7 mm carapace length left the burrows and appeared in the open water from September through mid-December. These juveniles reached adult size (28.0 to 32.0 mm carapace length) by July or August of the following year. Penn (1943) reported edible size for *P. clarkii* at 30.0 mm carapace length; similar sized individuals of *P. hayi* were most abundant in open water during spring and early summer.

METHODS OF STUDY

In July and August of 1967, the peak of ovarian egg development, adult females were removed from the study ponds, their ovaries removed and placed in 70% ethyl alcohol solution, and counts of ovarian eggs made by removing eggs singly with forceps and probe. Total counts were made for 76 adult females varying in carapace length from 35 to 47 mm.

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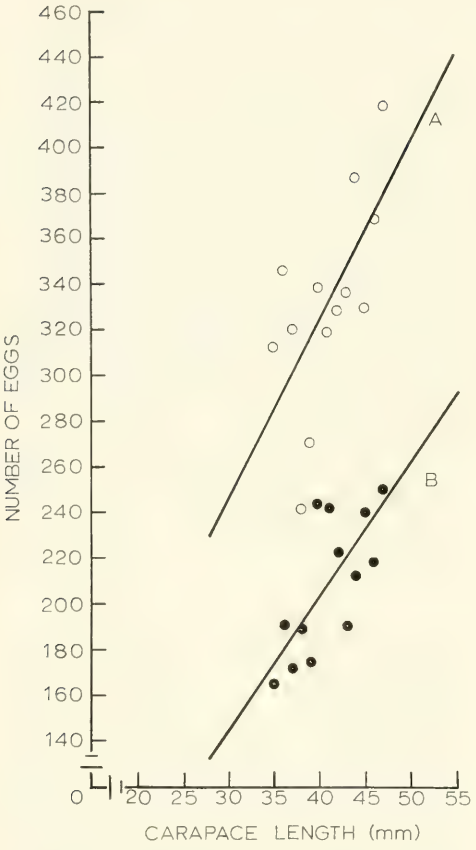

Figure 1. Regression of number of eggs on carapace length of *Procambarus hayi*. Line A represents ovarian eggs (regression equation: $8.33 + 7.87X$); line B represents abdominal eggs (regression equation: $-34.31 + 5.91X$). In the scatter diagram, open circles are means of ovarian egg counts; dark circles are means of abdominal egg counts.

Counts of abdominal, or extruded eggs were made on individuals confined in laboratory aquaria. Following oviposition females were removed from the aquaria, their carapace length measured, and the abdominal eggs counted. It is believed that more accurate counts of extruded eggs were obtained on these females than on those collected in the field, for securing ovigerous females in their native habitat required complete excavation of their burrows. Such disturbances and handling resulted in the loss of many eggs; consequently, data from these excavated females were not included in the regression analysis presented below. From June, 1966, through March, 1968, 64 females became ovigerous in the laboratory aquaria.

Results and Discussion

Maximum and minimum egg counts for each mm size class are given in Table 1. Ovarian egg counts ranged from 221 to 463; abdominal egg counts ranged from 60 to 340. The number of eggs varied considerably in different specimens, however, a positive correlation existed between carapace length and number of eggs produced and laid (Fig. 1). The correlation coefficient for ovarian eggs was 0.630 and that for abdominal eggs was 0.663. Regression analysis revealed that for each 1 mm increase in carapace length there was a corresponding 7.87 increase in ovarian eggs and a 5.91 increase in abdominal eggs. A direct relationship between length and total number of abdominal eggs was first noted by van Deventer (1937) in studies of *O. propinquus*; other investigators reported similar findings for ovarian or abdominal

Table 1. Ovarian and abdominal egg counts for various size categories of *Procambarus hayi*.

Carapace Length (mm)	Sample Range Ovarian Eggs	Integral Mean Ovarian Eggs	Sample Range Abdominal Eggs	Integral Mean Abdominal Eggs
35	275–340	312	110–211	165
36	311–375	346	148–230	191
37	234–381	320	160–180	171
38	221–295	241	128–260	190
39	236–325	270	82–225	174
40	258–417	339	85–300	244
41	220–421	318	180–288	242
42	279–311	328	122–286	222
43	268–387	336	128–280	190
44	350–426	386	135–340	212
45	222–417	329	200–273	240
46	315–427	368	60–218	218
47	382–463	418	241–259	250

eggs in various species (Tack, 1941; Penn, 1943; Smart, 1962 and Prins, 1968).

Consistently fewer abdominal eggs were noted when compared with ovarian egg counts from the same female size category; the margin of difference between the two measurements increased with carapace length (Fig. 1). Prins (1968) reported a similar condition in *O. r. rusticus* and attributed differences in part to the rigors of the lotic environment of this species. In *P. hayi* smaller numbers of extruded eggs apparently resulted from several causes: failure of certain eggs to be fertilized and/or attached; loss of some eggs to predation by the brooding female; and incomplete extrusion of eggs. Penn (1943) and Smith (1953) reported that other species failed to extrude completely all of the ovarian eggs; a resorption of remaining eggs followed.

For specimens with carapace length of 35.0 to 43.0 mm, the figures reported here compare favorably with those noted for *P. clarkii* by Penn (1943). Samples from larger specimens indicated that *P. clarkii* had a greater reproductive potential. Larger specimens of *P. hayi* probably compare more closely with *P. a. acutus*, although no data on fecundity for this species are available. LaCaze (1966) indicated *P. a. acutus* was less productive than *P. clarkii* but still capable of producing excellent crops when properly stocked.

Summary and Conclusions

1. Fecundity studies of the pond crawfish, *Procambarus hayi*, were conducted utilizing total ovarian and abdominal egg counts from females ranging from 35.0 to 47.0 mm carapace length.

2. Ovarian egg counts were made on specimens collected from two ponds in the vicinity of State College, Mississippi; abdominal egg counts were taken from specimens confined in laboratory aquaria since females in the habitat retreat to burrows for oviposition.

3. A positive correlation existed between carapace length and total number of ovarian and abdominal eggs produced. In each category females consistently produced more ovarian than abdominal eggs. Females ranging in carapace length from 35.0 to 43.0 mm exhibited potential fecundity equivalent to that of *P. clarkii*, a commercially important species in Louisiana. Fecundity and relative abundance in shallow farm ponds in northern Mississippi indicate that *P. hayi* has commercial harvest potential.

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September 30, 1971

A NEW SPECIES OF *PERICLIMENAEUS* BORRADAILE, 1915 (CRUSTACEA: DECAPODA: PALAEMONIDAE) FROM THE NORTHEASTERN GULF OF MEXICO[1]

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ABSTRACT

A new species of *Periclimenaeus* is described from the northeastern Gulf of Mexico off the west coast of Florida. It is closest to *P. atlanticus* (Rathbun, 1901) but can be distinguished from that species in that the anterior pair of dorsal spines of the telson arise in the anterior sixth of the segment rather than at the end of the anterior third as in *P. atlanticus*.

This new species of palaemonid shrimp was discovered during a survey of the decapod crustacean fauna of the northeastern Gulf of Mexico. It is reported on now as it will be some time before a complete report will be ready for publication.

I thank Dr. Fenner A. Chace, Jr. for pointing out the distinctness of this species and for placing at my disposal a portion of his unpublished manuscript on the natantian decapods of the West Indies. The Florida State University System's Institute of Oceanography provided ship time.

The abbreviation *tl* refers to total length measured from the posterior margin of the or bit to the tip of the telson, *cl* refers to carapace length measured from the posterior margin of the orbit to the posterior margin of the carapace, and USNM refers to the National Museum of Natural History (formerly U. S. National Museum), Smithsonian Institution.

Periclimenaeus ***chacei*** new species

Material. Holotype: 1 ovigerous female, *tl* 8 mm, *cl* 2.3 mm; Gulf of Mexico; off the West coast of Florida; 28°31′N, 84°16′W; 26 m; Petersen grab; coral rubble bottom; 9 April 1970; coll. L. G. Abele; "Tursiops" cruise 70–12, st. 16; USNM 137910. Paratype: 1 male, *tl* 5 mm, *cl* 1.8 mm; locality data as for holotype; USNM 137911.

Description. The rostrum is smooth and directed slightly downwards. It falls slightly short of the distal margin of the basal antennular segment. The rostrum is armed dorsally with four equally spaced, distinct teeth, excluding the tip of the rostrum. The first is placed anterior to the margin of the orbit and the last tooth is about one-third of the distance from the acute tip. The teeth become more forwardly directed distally. The ventral margin is unarmed and convex with a very slight emargination about half the distance from the tip. A strong antennal spine is present at the lower margin of the orbit. The anterolateral angle of the carapace is broadly rounded and anteriorly produced. The carapace is smooth and no spines other than the antennal are present.

The abdomen is smooth. All pleura are rounded posterolaterally although the sixth tends to be somewhat subacute there. The pleura of the female are more broadly rounded than in the male, especially the third and fourth which are much expanded. A small tubercle is present on the anterolateral margin of one of the sixth pleura of the male, which is lacking on the other side. The fifth and sixth segments are subequal in length and each is half as long as the telson. There is a median projection ending in a small lobe on the ventral surface of the fifth abdominal somite of the male which is lacking on the female. The telson decreases evenly in width from anterior to posterior with the posterior margin being about half as wide as the anterior margin. The length is slightly more than twice the width. The telson is armed with two pairs of dorsal

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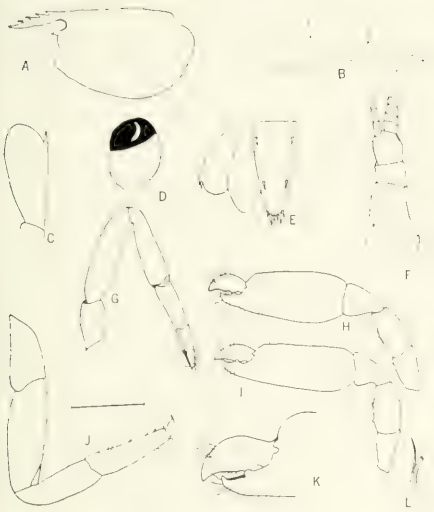

Figure 1. *Periclimenaeus chacei* n. sp. Paratype male (except E). A, carapace. B, lateral view of last three abdominal segments. C, scaphocerite. D, eye. E, telson and left pair of uropods. F, antennule. G, first pereiopod. H, male cheliped. I, female cheliped. J, third pereiopod. K, anterior portion of male chela. L, appendix masculina and appendix interna. Scale = 2 mm for A, E, H, I; 1 mm for others.

spines. The first pair is located about one-sixth of the distance from the anterior margin and the second pair is located about three-fifths of the distance from the anterior margin. The spines are large and are adjacent to the lateral margins. The posterior margin of the telson is armed with three pairs of spines with the lateral pair being placed slightly anterior to the intermediate and submedian pairs. The intermediate pair is longer than the submedian pair which is longer than the lateral pair.

The cornea is rounded and well pigmented; it is slightly over half the length of the eye peduncle.

The stylocerite of the antennule is short and broad with a subacute tip. It falls well short of the middle of the basal segment of the antennular peduncle. The lateral margin of the basal segment is laterally expanded forming a blunt lobe slightly distal to the tip of the stylocerite. A small spine is present on the distal lateral margin of the basal segment. Another small spine is present on the ventral surface of the basal segment at about the same level as the blunt lobe but towards the medial rather than the lateral margin. The basal segment is over three times as long as the penultimate and slightly over twice as long as the ultimate segment.

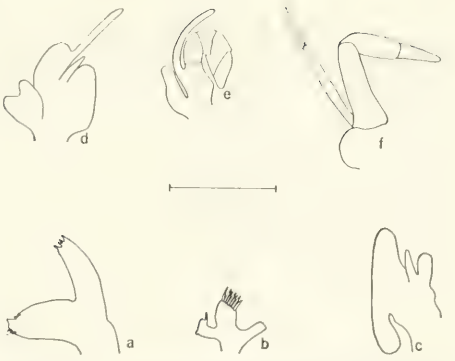

Figure 2. *Periclimenaeus chacei* n. sp. Paratype male. a, mandible. b, maxillula. c, maxilla. d, first maxilliped. e, second maxilliped. f, third maxilliped. Scale = 1 mm for b–f; 0.5 mm for a.

The outer antennular flagellum has the rami fused for five articles, the shorter one being free for one article only.

The scaphocerite increases in width distally. The length is over twice the greatest width. The outer margin is straight and ends in a strong tooth which does not extend to the distal margin of the lamella. There is no spine on the base of the scaphocerite. The scaphocerite falls slightly short of the distal margin of the ultimate segment of the antennular peduncle.

The incisor process of the mandible ends in four teeth. The molar process ends in one spine with setae present. The palp of the maxillula has a small lobe armed with a small spine on the medial distal margin; the upper endite is armed with about seven strong spines along the distal margin; the lower endite is narrower than the upper and is truncate distally. The maxilla has the inner endite simple and slightly shorter than the palp; the scaphognathite is relatively narrow. The first maxilliped has the coxal and basal endites fused; the flagellum of the exopod is well-developed and the caridean lobe is longer than broad; the epipod is distinctly bilobed. The second maxilliped is typical; the exopod is long and strong and an epipod is present. The third maxilliped extends to about the middle of the scaphocerite. The ultimate segment is about half as long as the antepenultimate and two-thirds as long as the penultimate. The distal two segments are relatively broad, the penultimate being about three times as long as broad. The exopod is longer than the antepenultimate segment and an epipod is present. The branchial formula is the following:

	Maxillipeds			*Pereiopods*				
	1	2	3	1	2	3	4	5
Pleurobranch	–	–	–	1	1	1	1	1
Arthrobranch	–	–	–	–	–	–	–	–
Podobranch	–	–	–	–	–	–	–	–
Epipod	1	1	1	–	–	–	–	–
Exopod	1	1	1	–	–	–	–	–

The first legs are equal. They extend beyond the scaphocerite by the full length of the carpus. The fingers are slightly shorter than the palm, are unarmed and taper slightly to the tips. The chela is slightly longer than the carpus. The merus is longer than the carpus and slightly over twice as long as the ischium. On both specimens only the larger of the second legs is present. They extend beyond the scaphocerite by the length of the carpus. The chela is smooth. The movable finger is about one-third as long as the palm and extends distinctly beyond the immovable finger. The upper margin is strongly convex. The movable finger is armed in the proximal portion with a large blunt tooth which fits into a cavity on the immovable finger. Adjacent to this cavity on the lateral margin of the immovable finger is a blunt tooth. The edge of the movable finger is finely serrate anterior to the blunt tooth. The immovable finger is slightly spoon-shaped anterior to the cavity. The palm is large and swollen and is highest in the proximal portion. The carpus widens greatly in the distal portion and is less than half as long as the palm. The merus is armed along the inferior margin with about five small tubercles and is about half as long as the palm. The ischium is shorter than the merus and may be armed with a small tubercle on the inferior margin. The chela of the larger second leg of the female is not as strongly swollen as that of the male. The movable finger is not as convex and the palm is proportionately longer and changes little in height from proximal to distal. The third through the fifth pereiopods are similar. The third pereiopod extends beyond the scaphocerite by a portion of the propodus. The propodus is armed with two small spines, one in the distal part of the inferior margin just proximal to the dactylus and the other just proximal to the first. The dactylus is short and ends in a distinct spine. The carpus is a little longer than the propodus. The merus is longer than either the propodus or the carpus. The ischium is shorter than the propodus.

The first pleopods in both sexes lack an appendix interna. The endopod of the first female pleopod is about half as wide and half as long as the exopod with the distal margin acute. The endopod of the first pleopod of the male is over half as wide but less than half as long as the exopod with the distal margin rounded. An appendix masculina is present on the second pleopod of the male. It is less than half as long as the appendix interna and ends in a long strong seta which extends far beyond the appendix interna. The uropods are broadly ovate, the endopod narrows distally and extends beyond the exopod. The distal margin of the exopod is somewhat truncate and extends beyond both the immovable outer tooth and the longer movable spine which is present just inside the immovable tooth. A diaeresis is absent.

The present female carried about 60 eggs, each about 0.5 × 0.6 mm, which were early in development.

The specimens, in life, were white. The eggs were a light green color.

Etymology. The specific name is given for Dr. Fenner A. Chace, Jr., of the National Museum of Natural History, who is always so willing to offer help and encouragement to those interested in carcinology.

Remarks. The species is known only from the type locality, a poorly developed patch reef. The specimens were collected with a Petersen grab.

Discussion. Periclimenaeus chacei seems to be closest to *P. atlanticus* (Rathbun, 1901) but can be distinguished from that species in that the anterior pair of dorsal spines of the telson arise in the anterior sixth of the segment rather than at the end of the anterior third as in *P. atlanticus*. The major chelae of these two species are quite dissimilar. The chela of *P. atlanticus*, based on a specimen in the National Museum of Natural History (USNM 135532), has both fingers strongly hooked, and curved in a horizontal (perpendicular to the plane of the palm) plane. The movable finger does not extend beyond the immovable finger. The lobe on the movable finger is large and robust, occupying most of the proximal half of the finger. The fingers of the chela of *P. chacei* are not strongly hooked, do not curve in a horizontal plane, and the movable finger extends distinctly beyond the immovable one. The lobe on the movable finger is relatively small and occupies only a small portion of the proximal half of the finger. In *P. atlanticus* the lateral tooth of the scaphocerite extends to, or slightly beyond the distal margin of the lamella, while in *P. chacei* the distal margin of the lamella extends distinctly beyond the lateral tooth of the scaphocerite.

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TRICHODACTYLIDAE FROM VENEZUELA, COLOMBIA, AND ECUADOR (CRUSTACEA: BRACHYURA)

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Apartado 1827, Caracas, Venèzuela p. 41

NOTES ON SKELETAL VARIATION, TOOTH REPLACEMENT, AND CRANIAL SUTURE CLOSURE OF THE PORCUPINE (*ERETHIZON DORSATUM*)

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Department of Zoology, Southern Illinois University, Carbondale, Illinois 62901
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REVISION OF *LOUTERIDIUM* (ACANTHACEAE)

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TULANE STUDIES IN ZOOLOGY AND BOTANY

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TRICHODACTYLIDAE FROM VENEZUELA, COLOMBIA, AND ECUADOR (CRUSTACEA: BRACHYURA)

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ABSTRACT

The freshwater crabs of the family Trichodactylidae from Venezuela, Colombia, and Ecuador, are described. Species considered are *Trichodactylus* (*Rodriguezia*) *quinquedentatus*, *Sylviocarcinus torresi*, *S. piriformis*, *S.* ***gigas*** (new from Amazon drainage of Colombia), *S. pictus*, *Zilchiopsis ecuadoriensis*, *Valdivia serrata*, *V. venezuelensis*, *Dilocarcinus* (*Dilocarcinus*) *niceforei*, *D.* (*D.*) *dentatus*, and *D.* (*D.*) ***medemi*** (new from northern Colombia).

INTRODUCTION

The limited material of freshwater crabs from South America available for taxonomic studies has been an important factor contributing to the confusion over their classification. We have been able to collect, and acquire from other collectors, material from several areas in northern South America, and are thus able to present descriptions and figures which we hope will resolve some current problems and help future workers overcome the current chaotic conditions in freshwater crab taxonomy. Included in our material are two new species from Colombia.

There is no classification which will satisfactorily accommodate all of the species discussed in this paper. We have chosen to follow Bott (1969) rather than Pretzmann (1968b), mainly because Bott provides adequite descriptions and justification for his genera and subgenera, as well as a key which will serve for all of the material discussed below. We have not examined enough material from Brazil and Argentina to enable us to evaluate and compare the two classifications in complete detail. We do not recognize *Forsteria*, which includes only one species, *Valdivia venezuelensis*.

Bott has a more inclusive concept of the lower taxa than either Pretzmann or ourselves, so it often happens that we will recognize species which Bott will consider merely a variation of some other species or subspecies. In addition, we have tried to avoid subspecies altogether, since in our opinion many of the subspecies of freshwater crabs described in recent years are based on entirely inadequate material.

The species from Venezuela, Colombia, and Ecuador discussed in this paper are as follows:

Trichodactylus (*Rodriguezia*) *quinquedentatus* Rathbun, 1893

Sylviocarcinus torresi (Pretzmann, 1968)

Sylviocarcinus piriformis (Pretzmann, 1968)

Sylviocarcinus gigas new species

Sylviocarcinus pictus (Milne Edwards, 1853)

Zilchiopsis ecuadoriensis (Pretzmann, 1968)

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Valdivia serrata White, 1847
Valdivia venezuelensis Rathbun, 1906
Dilocarcinus (*Dilocarcinus*) *niceforei* (Schmitt and Pretzmann, 1968)
Dilocarcinus (*Dilocarcinus*) *dentatus* (Randall, 1839)
Dilocarcinus (*Dilocarcinus*) *medemi* new species

Measurements

Abbreviations are used for the most common measurements, as follows: (cb), carapace breadth, the greatest width of the carapace; (cl), carapace length, the median length of the carapace; (fow), fronto-orbital width, the distance between the outer orbital angles; (ft), front, the part of the anterior margin of the carapace delimited by the outermost points of the concave curve where the front of the carapace begins to form the posterior border of the orbit. Measurements are always given in this order. In some species, where good series are available from one locality, only representative measurements are given, since the linear proportion of parts of the carapace remains the same in crabs of different size. This is established for a species of Pseudothelphusidae by Chace and Hobbs (1969), and is also true for Trichodactylidae.

Acknowledgments

Material from Colombia and Ecuador was especially collected and sent to us by Mr. Manuel Olalla (Quinto), Mr. Agustín Zamora (Santa Marta), and Brother Niceforo Maria (Bogotá). A collection of decapod Crustacea donated to Tulane University by Dr. Frederico Medem (Cartagena) contained two species of Trichodactylidae. Specimens from the National Museum of Natural History were kindly provided by Dr. Waldo L. Schmitt and Mr. Henry B. Roberts. Dr. Dale Little and Mr. Gary Epler (Tulane University) contributed specimens from Colombia collected during research on paragonimiasis; Dr. N. R. Foster sent some crabs from Venezuela. Mr. Jackson E. Lewis examined the holotype of *Trichodactylus quinquedentatus* for us. To all of these we wish to express our deepest appreciation.

This research was supported in part by the Tulane University Center for Medical Research and Training, Grant No. TW00143 from N. I. A. I. D., National Institutes of Health, U. S. Public Health Service, and a grant from the National Science Foundation (GB-3505).

Key to the Trichodactylidae of Venezuela, Colombia, and Ecuador

1. Anterolateral border of carapace bearing 2–5 teeth, excluding orbital 2
1. Anterolateral border of carapace bearing 7–9 teeth, excluding orbital ..... *Dilocarcinus* 9
2. All abdominal segments free in both sexes; gonopod short, straight; 5 teeth on anterolateral border of carapace, excluding orbital angle; small species ..... *Trichodactylus* (*Rodriguezia*) *quinquedentatus*
2. Abdominal segments 3–5 or 3–6 fused 3
3. Male gonopods curving inward ..... *Sylviocarcinus* 4
3. Male gonopods curving outward, or nearly straight 7
4. Outer edge of gonopod with strong protuberance or hump 5
4. Outer edge of gonopod nearly straight 6
5. Gonopod stout (Fig. 6) ..... *Sylviocarcinus gigas*
5. Gonopod slender (Fig. 8) ..... *Sylviocarcinus pictus*
6. Margin of gonopod curved laterad so as to disappear around outer edge; spines of caudal area sparse ..... *Sylviocarcinus torresi*
6. Margin of gonopod straight, not disappearing around outer edge; spines of caudal area dense; range does not overlap with *S. torresi* ..... *Sylviocarcinus piriformis*
7. Male gonopod nearly straight; armed with heavy setae or light spines ..... *Zilchiopsis ecuadoriensis*
7. Male gonopod curved outward; at least some of the spines heavy ..... *Valdivia* 8
8. Distal portion of gonopod with approximately parallel sides ..... *Valdivia serrata*
8. Distal portion of gonopod curved; strong lateral protuberance ..... *Valdivia venezuelensis*

9. Gonopod strongly curved distally; tip bulbous ..... *Dilocarcinus niceforei*
9. Gonopod gently curved distally; tip slender or slightly bulbous 10
   10. Margin curving outward around gonopod; marginal protuberance bearing setae obtuse *Dilocarcinus dentatus*
   10. Margin not curving outward around gonopod; marginal protuberance bearing setae acute *Dilocarcinus medemi*

Systematic Account

Trichodactylus (*Rodriguezia*) *quinquedentatus* Rathbun, 1893

Figs. 1 and 2

Trichodactylus quinquedentatus Rathbun, 1893, p. 660, Pl. LXXVII, Fig. 7.

T. (*Trichodactylus*) *quinquedentatus.* Rathbun, 1906, p. 42, Pl. XV, Fig. 3; Pretzmann, 1968b, p. 70.

T. (*Rodriguezia*) *quinquedentatus.* Bott, 1969, p. 27.

Description: Carapace subcircular, widest at level of fourth lateral spine, very convex anteriorly-posteriorly. Front bilobed, produced. Outer margin of orbit rounded, not produced as spine or sharp angle. Antero-lateral margin of carapace strongly arcuate, armed with five teeth, not including orbital angle. Lobe between outer orbital angle and first carapace tooth; first three teeth larger than fourth and fifth; fifth tooth small, on posterior margin of carapace; first and second teeth curving anteriorly, forming elongate notches between teeth and carapace margin. Lower margin of orbit not tuberculate, with deep sinus about three-fourths distance from lateral border of orbit; termination of margin smooth or with sharp tooth; female holotype with low protuberance; sinus followed medially by strong tooth, blunt or sharp, directed medially, somewhat appressed. Antero-lateral margin of buccal angle unarmed.

Chelipeds of largest male very unequal, hand of largest cheliped being as long as carapace wide. Merus with sharp spine on outer border; similar spine on inner margin; upper border ending in sharp tooth. Carpus with long hooked spine on inner margin. Surface of cheliped polished, densely covered with punctae visible to naked eye.

Abdominal segments all free in both sexes. Seventh abdominal segment of male broadly rounded.

Gonopod short, straight, with truncated apex; lateral surface and mesial surface each with irregular longitudinal row of blunt, conical, slightly recurved spines. Marginal setae moderately developed, born on gently rounded protuberance. Second gonopod longer than first.

Color: Specimens preserved in alcohol are reddish brown. The large chela of the largest male has a reddish palm and the fingers are a creamy white.

Size: This is a small species; Pearse (1921) noted that the largest specimen in a collection of a hundred had a cb. of 25.5 mm.

Material Examined: Colombia: Rio Fundación, near Santa Marta, Depto. Magdalena; 13 Nov 1967; Agustín Zamora; 2 males, cb. 24.4, 19.0 mm, cl. 20.5, 15.8 mm.—Rio Cesar, 10 km S Valledupar, Depto. Magdalena; 25 Jan 1968; Agustín Zamora; 4 males, cb. 20.0, 17.4, 16.4, 12.6 mm; cl. 16.9, 15.5, 14.8, 11.5 mm; three females, cb. 19.7, 18.5, 12.8 mm, cl. 17.2, 15.7, 11.7 mm.—Rio Sevilla, Santa Marta, Depto. Magdalena; 15 Nov 1967; Agustín Zamora; 1 male, cb. 21.5 mm, cl. 18.9 mm, 2 females, cb. 18.2, 15.2 mm, cl. 16.2, 13.4 mm.—Rio Gaira, near Santa Marta, Depto. Magdalena; 15 Nov 1967; Agustín Zamora; 1 male, cb. 21.3 mm, cl. 18.4 mm, 1 female, cb. 15.0 mm, cl. 13.7 mm. —Quebrado Matogiro, Finca "El Aranar", near Bonda, Depto. Magdalena; 14 July 1964; F. Medem and C. Velásquez; 1 male, cb. 19.0 mm, cl. 16.9 mm, (TU-4865).—Rio Aracataca, near Santa Marta, Depto. Magdalena; 9 Nov 1967; Agustín Zamora; 1 male, 1 female, 3 juveniles. —Cartegena, Depto. Bolivar; 11 Aug 1969; collector unknown, received from M. D. Little; 1 male, cb. 23.0 mm, cl. 20.0 mm, (TU-6190).

Type and Distribution: The holotype is a female from the Rio Escondido, near Rama, 50 miles from Bluefields, Nicaragua. The species has been reported since from Ibague, near Tolima, Colombia (Doflein, 1899), from Santa Marta, Colombia (Pearse, 1921), and from Barranquilla, Colombia (Zimmer, 1912). In Colombia, the species seems to be restricted to the Magdalena Valley. The disjunct distribution of this species in Nicaragua and Colombia is unusual when compared with the distribution of other species of the family. Unfortunately, the only known Nicaraguan specimen is a female; however, the suborbital margin is very distinctive in this species, and in our opinion the similarity of the Nicaraguan holotype to the Colombian specimens is sufficiently close to confirm the

conclusion of previous workers that they are the same species.

Sylviocarcinus torresi (Pretzmann, 1968)

Figs. 3 and 4

Valdivia (*Valdivia*) *torresi* Pretzmann, 1968b, p. 72.

Description: Carapace regularly convex in both directions; regions poorly marked. Margin of front straight or slightly concave; upper surface not curving downward. Anterolateral margin of carapace with five teeth including orbital. Orbital tooth wide, pointed, external border straight or slightly convex. Second to fourth teeth wide, well developed, regularly spaced. Fifth tooth located slightly behind middle of carapace, small, sometimes rudimentary, widely separated from fourth tooth. Lateroposterior margin of carapace with thin carina. Lower orbital margin with seven or eight regularly spaced papillae. Crest of antero-buccal angle with internal tooth followed by two or three small papillae.

Chelipeds unequal; distal corner of upper border of merus and middle of lower border of merus each bearing spine; lateral border produced in sharp tooth; internal border of carpus with single spine. Upper and lower margins of dactylus and propodus of ambulatory legs very setose. Third to fifth abdominal segments fused in both sexes.

Gonopod with double or bicarinate lateral lobe. Aperture at terminus of margin lateral, not at tip.

Surface of carapace and most surface of pereiopods covered by small granules visible to naked eye.

Color: The specimens preserved in alcohol have a deep brown carapace with small lighter spots.

Material Examined: Colombia: Rio Fundacion, near Santa Marta, Depto. Magdalena; 25 January 1968; Agustín Zamora; 2 males, 1 female.—Rio Cesar, 10 km S Valledupar, Depto. Magdalena; 25 January 1968; Agustín Zamora; 2 males, 1 spent female, 1 immature female.—Rio Aracataca, near Santa Marta, Depto. Magdalena; 16 November 1967; Agustín Zamora; 7 young males, 3 young females.—Rio Sevilla, near Santa Marta; 15 November 1967; Agustín Zamora; 1 young female.

Type and Distribution: The holotype is a male from La Regla, Depto. Bolivar, Colombia. The species is restricted to the Santa Marta region and the drainage of the Rio Magdalena.

Table 1. Measurements of *Valdivia torresi.*

	cl.	Anterior cb.	Posterior cb.	fow.
		Rio Fundacion		
Male	51.5	53.5	52.0	34.2
Male	53.0	54.8	53.8	37.0
Female	51.8	54.3	52.5	34.9
		Rio Cesar		
Male	50.8	52.0	51.0	35.0
Male	44.8	47.0	46.5	31.8
Female	45.2	48.0	46.0	31.3
Female	30.0	31.3	29.9	22.0
		Rio Aracutaca		
Male	27.4	30.5	29.7	21.0
Female	23.4	25.2	24.4	17.8
Male	20.0	21.2	20.2	15.6
Male	18.5	19.0	18.6	14.3
Male	14.6	15.1	14.5	11.9

Remarks: In the young specimens (up to 32.5 mm carapace width), the teeth of the anterolateral border of the carapace are slender and sharp, with the borders serrated. The margin of the front is lined with round granules, and the upper surface of the front is conspicuously excavated. In the smaller specimens (cb. 23 mm) the merus has two small sharp spines on the lateral border, in addition to the tooth located distally. These spines are sometimes represented in adults by one or two tubercles. The carapace of younger specimens are flatter and more irregular than in the older crabs.

Valdivia torresi is also very close to *V. piriformis* Pretzmann. Juvenile specimens are almost impossible to separate, except by the collection locality. However, in older specimens of *V. piriformis* the lateral walls of the carapace become swollen, giving the body a pear-shaped appearance. In *V. torresi* the anterior portion of the carapace is always wider than the posterior portion (Table 1); this species does not seem to attain the very large size of *V. piriformis.* Bott (1969, p. 38) suggests that *Valdivia torresi* and *V. piriformis* are both synonyms of *Valdivia* (*Forsteria*) *venezuelensis edentata.* However, the gonopods are of such a different shape that we do not think they are related.

Sylviocarcinus piriformis
(Pretzmann, 1968)
Fig. 5

Valdivia (*Valdivia*) *piriformis* Pretzmann, 1968b, p. 73; Schmitt, 1969, p. 98, Fig. 3, a–e, f–i.

Description: Carapace moderately convex in specimens up to 32 mm carapace length; more strongly convex in larger specimens. Carapace subquadrate in smaller specimens, widest between third or fourth pair of teeth, anterior to middle of carapace; in larger specimens becoming subquadrate to piriform, widest behind fourth lateral tooth, posterior to middle of carapace due to swelling of lateral wall of branchial chamber; finally in largest specimens becoming orbicular with posterior lateral walls considerably swollen. In small specimens, anterolateral teeth of carapace four to five, including orbital, fifth rudimentary when present, others prominent with slender tips. In large specimens (42 to 73 mm carapace length) four to five anterolateral teeth including orbital, orbital small, well-defined, sharply pointed, remaining teeth blunt, low, sometimes reduced to swelling with small papilla; in largest specimens (74.8 and 78.8 mm carapace length) becoming obsolete or represented by a small round papilla. Margin of front slightly concave; lower margin of orbit with large internal tooth, followed by usually nine tubercles, diminishing in size externally; anterolateral buccal angle bearing internal triangular tooth followed externally by three of four small tubercles.

Chelae moderately unequal in small specimens, becoming very unequal with increasing size; in largest specimen, major chela exceeding width of carapace by almost entire length of ischium; length of largest palm 1.3 length of carapace.

Third to fifth abdominal segments fused in both male and female.

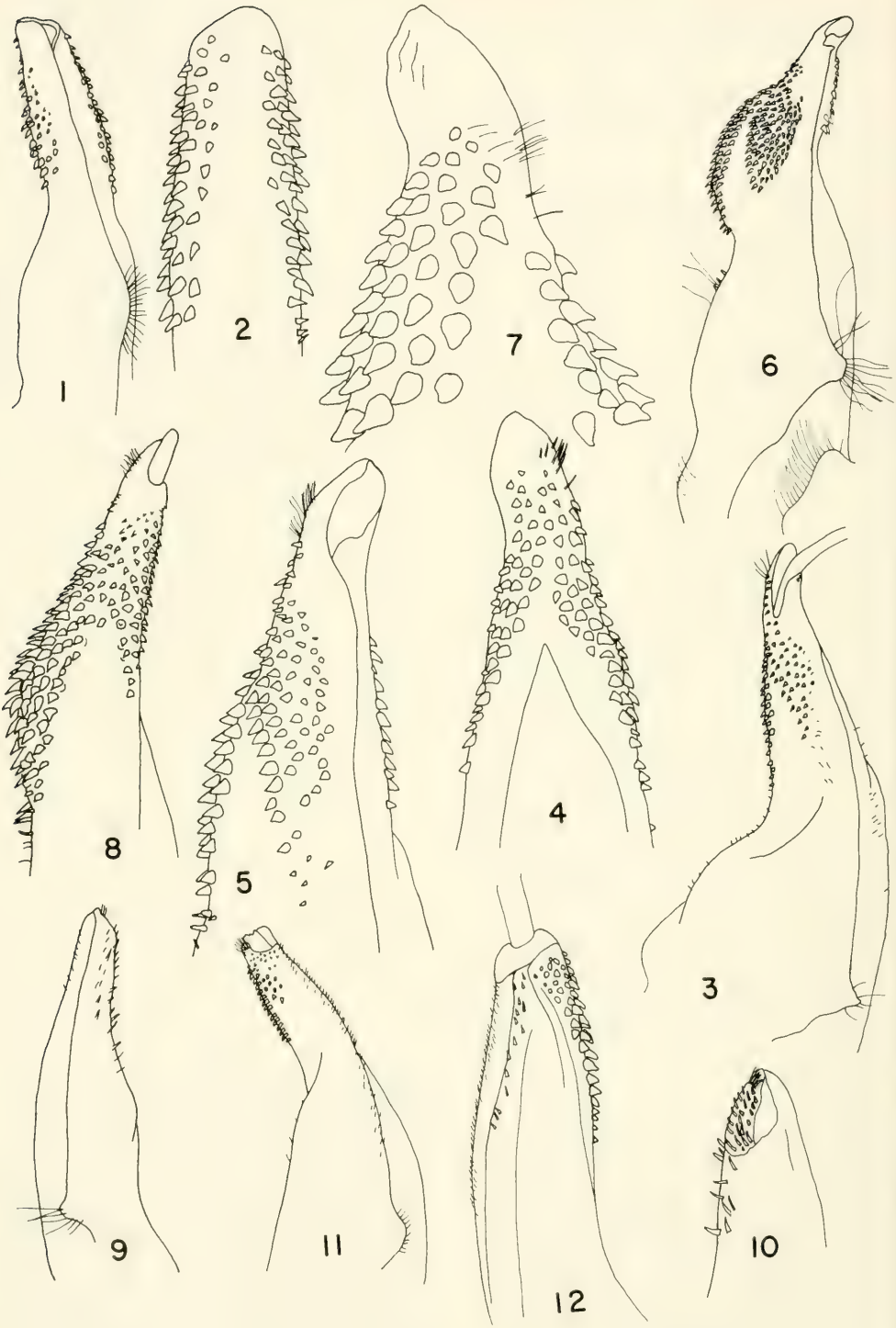
First gonopod curving slightly mesiad; margin almost straight; prominence bearing marginal setae very pronounced, somewhat angular in outline. Gonopod bearing three spine fields, one on either side of margin, a third on mesial edge, the three fields coalescing near tip.

Size: Measurements of *Sylviocarcinus piriformis* are given in Table 2.

Table 2. Measurements of *Valdivia piriformis*.

	cl.	Anterior cb.	Posterior cb.	fow.
		Isiro Dam		
Male	78.8	77.7	83.7	55.4
Male	72.5	71.0	74.8	51.4
		Rio Guasare		
Male	74.8	76.8	80.8	55.1
		Rio Negro Machiques		
Male	29.9	33.4	31.5	23.4
Female	27.5	30.4	28.8	21.6
Female	25.8	27.4	26.5	20.3
Female	17.9	19.7	18.8	15.0
Female	13.5	14.6	14.0	11.5
		Rio Negro Tokio		
Male	43.7	43.5	44.2	32.4
		Mene Grande		
Male	31.6	34.0	32.0	25.4
Female	28.0	30.5	28.8	22.5
Female	28.7	31.4	29.0	23.2
Male	25.8	27.1	26.5	20.7
Female	24.8	27.6	25.7	19.8
Male	24.4	26.4	25.0	19.8
Male	17.0	18.6	17.7	14.4
		Chipuen		
Male	32.2	34.3	34.3	25.0
Male	28.5	31.0	29.9	22.8
Female	25.0	29.7	28.3	21.6
Male	25.2	26.8	26.1	20.7
		Rio Buena Vista		
Female	26.4	27.7	26.8	19.7
		Rio Onia		
Male	19.3	20.9	19.5	15.9

Material Examined: Venezuela: Isiro Dam, Estado de Falcon; J. Aguirre; 2 males.—10 km south of Mene Grande, Estado de Zulia; 23 February 1968; G. Rodriguez; 4 males, 4 females.—Quebrada Chipuen, near Valera, 350 m altitude, Estado de Trujillo; 14 February 1966; G. Rodriguez; 3 males, 1 female.—Rio Buena Vista, near the town of Buena Vista, 150 m altitude, Estado de Trujillo; 14 February 1966; G. Rodriguez; 1 female.—Rio Onia, tributary of Rio Escalante, near El Vigia, Estado de Merida; 23 April 1964; F. Mago; 1 male (MB).—Rio Negro, south of Machiques, Estado de Zulia; 8 April 1966; J. Ewald; 1 male, 4 females.—Rio Negro, Todio, 16 km west of Machiques, 280 m altitude, Estado de Zulia; 3 January 1950; F. Mar-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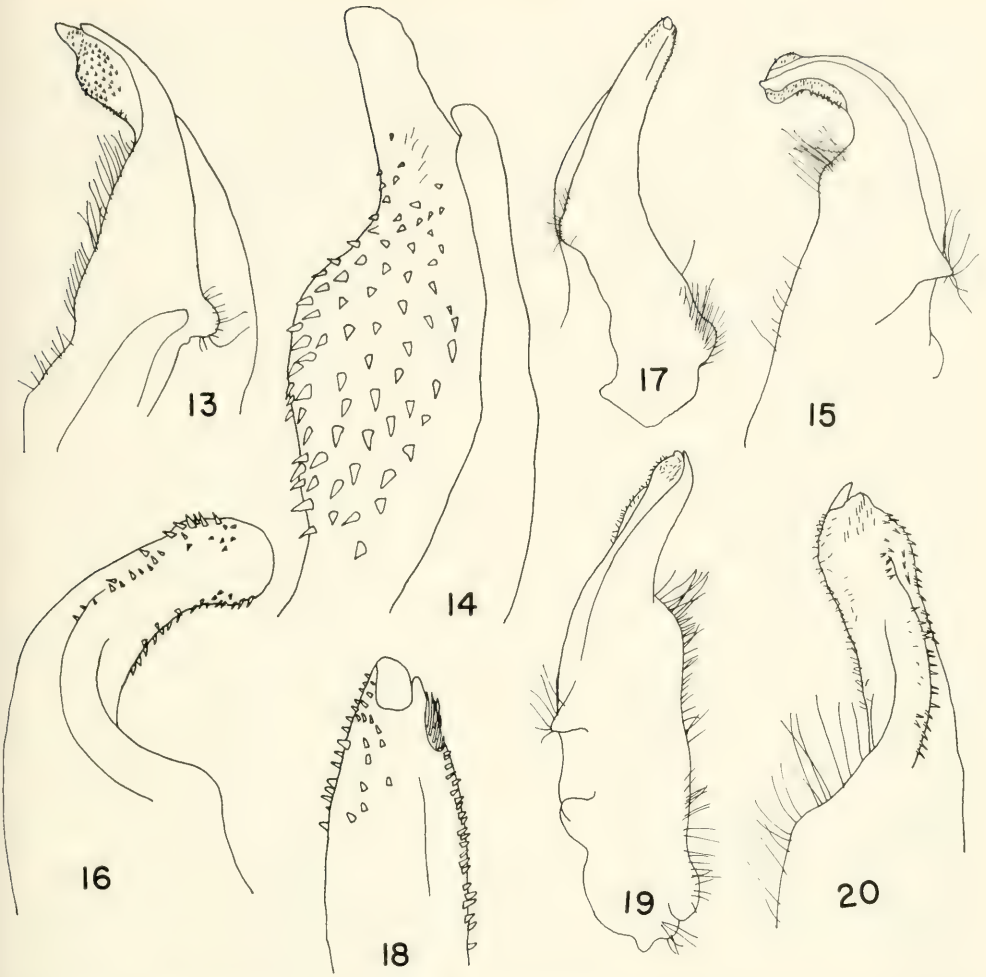


Figures 1–20. Right gonopod (Figs. 1–16) and left gonopod (Figs. 17–20) of Trichodactylidae. 1–2, *Trichodactylus quinquedentatus*; 3–4, *Sylviocarcinus torresi*; 5, *S. piriformis*; 6–7, *S. gigas*; 8, *S. pictus*; 9–10, *Zilchiopsis ecuadoriensis*; 11–12, *Valdivia serrata*; 13–14, *V. venezuelensis*; 15–16, *Dilocarcinus niceforei*; 17–18, *D. dentatus*; 19–20, *D. medemi*.

tin; 1 male (LS 66). Colombia: Cucuta, Norte de Santander; July 1941; Br. Niceforo; 2 males, 2 females; USNM 125412–125415.—Rio Sardinata, Norte de Santander; July 1947; Br. Niceforo; 2 males; USNM 125416–125417.—same locality; July 1941; Br. Niceforo; 1 male; USNM 125416; Puerto Santander, Norte de Santander; July 1947; Br. Niceforo; 1 female; USNM 125419.—Colombia, exact locality unknown; Br. Niceforo; 2 females; USNM 125410–125411.

Type and Distribution: The holotype is a male (cl. 48 mm) from Cucuta, Colombia. Our records show that this species is restricted to the Maracaibo depression.

Remarks: Bott (1969) suggests that *S. torresi* and *S. piriformis* are related to *Valdivia venezuelensis*; they are, however, distinct from the latter species.

The gonopods of *piriformis* and *torresi* are similar, except that in *torresi*, the lateral edge is straighter, and the spines of the caudal field sparser. The margin of *S. torresi* is somewhat more curved, and the prominence bearing the marginal setae is more triangular than that of *S. piriformis*. The cephalo-mesial angle of the gonopod of *S. piriformis* bears a small accessory tuft of spines proximal to

the large spine field; these spines are absent in *S. torresi.*

Sylviocarcinus ***gigas*** new species

Figs. 6–7, 21–22

Description: Carapace strongly arched toward front, sides curving down abruptly; slight downward curve posteriorly, large flat area in central posterior portion. Frontal margin of carapace gently bilobed, bearing 13 to 19 spines, quadrangular in shape; inconspicuous fissure in margin of carapace behind orbit. Outer orbital angle varying from rounded, blunt to distinctly spiniform. Anterolateral margin of carapace with 4 to 5 teeth including orbital; low round process between orbital and second tooth; in most specimens having 4 teeth, tubercle between third and fourth. Ventral border of orbit tuberculate, spine at inside corner. Anterolateral buccal angle bearing two spines, sharp in small specimens, blunt in larger specimens.

Inner borders of merus of third maxilliped strongly divergent, outer borders nearly straight; exopod long, about half length of merus; outer anterior border of merus carinate; tip notched at point of insertion of palp.

Anterior dorsal border of propodus of chelipeds with single spine near inner part of insertion of dactylus; each side of propodus with small tubercle at insertion of dactylus. Upper inner border of carpus with large spine. Upper and lower outer corners of merus bearing spines; lower inner border of merus with blunt spine about one-third distance from proximal articulation.

Third to fifth abdominal segments fused in male and female.

First male gonopod curving slightly mesiad with rounded tip abruptly bent mesiad at about forty-five degree angle. Lateral surface with prominent swelling, armed with heavy spines, divided by groove without spines; mesial surface with smaller patch of spines. Caudal surface flat, mostly without spines. Marginal process round, well defined.

Size: Largest male, 88.2–81.8–53.4–35.8 (the largest known specimen of Trichodactylidae); smallest male without carapace teeth, 72.1–65.6–44.8–28.5; largest female, 65.7–61.8–39.5–26.4; smallest specimen (a male, still recognizable from the gonopods as belonging to this species), 32.5–29.5–21.5–13.5. The front of this species is difficult to define, since it curves gradually into the posterior margin of the orbit; the distance measured is between the highest points of the postorbital elevation which is always present just lateral to the frontal tubercles and mesiad from the single postorbital fissure.

Material Examined: Colombia: Rio Orteguaza near Venecia, Amazon drainage, Depto. Caqueta; March 1966; collector unknown, received from Dr. M. D. Little; 13 males, 10 females, including the holotype.—Rio Putumayo at Puerto Asis, Amazon drainage, Depto. Putumayo; 18 July 1969; collector unknown, received from Dr. M. D. Little, 1 male.

Type and Distribution: The holotype (USNM-139120) and 11 male and 9 female paratypes (USNM-139121) have been deposited in the United States National Museum. Two males and one female paratype (TU-6187, TU-5342) have been deposited in the Tulane University collections.

Sylviocarcinus gigas has been found on the eastern slopes of the Andes in the Amazon drainage of Colombia.

Remarks: In this species, there is a distinct tendency for all spines and teeth to become blunt and low in larger specimens. Spination of the carapace and chelae is taken from large males, but in the extraordinarily large holotype (carapace length 81.8 mm), the carapace teeth have disappeared altogether, leaving only very low tubercles.

Sylviocarcinus gigas can be distinguished by the prominent protuberance on the lateral surface of the gonopod. The general curvature of the gonopod and the distribution of the heavy spines is similar to *S. torresi* and *S. piriformis.*

Sylviocarcinus pictus

(H. Milne Edwards, 1853)

Fig. 8

Dilocarcinus pictus H. Milne Edwards, 1853, p. 216.

Orthostoma pictum. Ortmann, 1897, p. 327, 328.

Trichodactylus (*Dilocarcinus*) *pictus.* Rathbun, 1906, p. 62, Pl. XIV, Fig. 9.

Holthuisia picta. Pretzmann, 1968b, p. 74.

Sylviocarcinus pictus pictus. Bott, 1969, p. 31, Pl. 12, fig. 22a, b, Pl. 21, fig. 53.

Description: Carapace regularly convex in both directions, front deeply bilobed. Anterolateral border of carapace bearing five to six teeth, including orbital; orbital tooth sharp, hooked, well-developed. Lower orbital border with three to four well developed spines medially, decreasing in size laterally, followed laterally by four tubercles. Anterolateral buccal angle with two well-developed, sharp spines.

Major chela very slender, dactylus slightly longer than palm, length of dactylus 5.5 times greatest width. Merus with tooth midway on inner border, strong tooth near tip of upper border; propodus with blunt distal tooth on upper border.

Third to fifth abdominal segments of male fused; abdomen of male with pair of round swellings between third and fourth segments.

First male gonopod with straight margin; prominence bearing marginal setae a gentle curve; lateral edge (viewed posteriorly) with curve at about two-fifths length of gonopod from base forming slight constriction; followed by strong outward curve, with slender tip. Single patch of heavy spines, extending proximally on lateral edge; very small patch of distal, lateral setae. Second gonopod much longer than first, with spade-shaped tip.

Color: Carapace and chelae covered with red spots and rings 1–2 mm in diameter, persistent in alcohol.

Material Examined: Colombia: Leticia, on the Amazon River, Depto. Amazonas; Brother Niceforo; 1 male, cb. 46.9 mm, cl. 40.5 mm, fow. 32.5 mm (MLaS).—Rio Arara, Leticia, Depto. Amazonas; 22 Aug 1969; collector unknown, received from Dr. M. D. Little; 1 male, cb. 41.2 mm, cl. 38.2 mm, fow. 32.9 mm, ft. 20.1 (TU-6189).

Type and Distribution: The types are two females from Loreto, Amazonas, Colombia. Rathbun (1906) added several specimens from French Guiana, the Amazon Basin (Nauta, Peru; Manaos, Villa Bella, and Pihauhy, Brazil) and the Paraguay River.

Remarks: Pretzmann (1968b) has described two subspecies, *S. picta rionegrensis*, and *S. picta collastinensis.* The latter name is probably derived from the city of Clatine, formerly called Collatina, Estado do Espiritu Santo, Brazil. Both these subspecies are apparently based on single specimens, one a female, the other a small male, and it is therefore not possible to form an opinion as to their validity.

Bott (1969) includes *Dilocarcinus margaritifrons* Ortmann, 1893 and *Trichodactylus (Valdivia) oronensis* Pretzmann, 1968, as well as both of the aforementioned new subspecies of Pretzmann, within *Sylviocarcinus pictus pictus*, and reduces *Dilocarcinus pardalinus* Gerstacker, 1856 to a subspecies of *S. pictus.* In our opinion, none of the students of the Trichodactylidae has adequately defined the varied populations of this species, most of which fall outside of our geographical boundaries.

Zilchiopsis ecuadoriensis
(Pretzmann, 1968)
Figs. 9 and 10

Trichodactylus (Valdivia) ecuadoriensis Pretzmann, 1968a, p. 3.

Valdivia (Valdivia) ecuadoriensis, Pretzmann, 1968b, p. 71.

Description: Carapace convex anteriorly; post-frontal lobes and gastric region considerably elevated over hepatic and frontal regions; posterior part of carapace flatter, surface less sculptured. Front strongly bilobed; space between lobes rounded or almost straight; under microscope margin of front marked by tuberculate ridge. Anterolateral border of carapace bearing two sharp teeth behind orbital; behind second tooth a rudimentary third tooth or low lobe. Orbital tooth wide, blunt, external margin concave in one specimen, slightly convex in another specimen.

Internal angle or lower orbital margin with wide round tooth, followed by smaller papillae diminishing in size toward external angle; anterolateral buccal angle with ridge, without teeth or spines.

Chelae moderately unequal; ischium without spines; merus with sharp spine midway on internal margin; lateral and internal borders unarmed; internal border of carpus with single spine; palm of chela with small terminal spine on upper margin. Third to sixth abdominal segments fused in both male and female.

First male gonopod curving slightly laterad, becoming narrow about two-thirds distance from base to tip; small scattered spines at tip, longest on lateral edge; distinct patch of small lateral teeth at tip; second gonopod about same length as first.

Material Examined: Ecuador: Loreto, Napo-Pastaza Province, foothills of Mt. Sumaco, 450 m altitude; June 1968; coll. Manuel Olalla; 2 males, cb. 20.5, 19.2 mm, cl. 18.5, 19.2 mm, fow. 15.7, 14.3 mm, 1 spent female, cb. 23.8 mm, cl. 21.0 mm, fow. 16.6 mm.

Type and Distribution: The holotype and only specimen reported in the literature is a male from Payamino, Napo-Pastaza Province, Ecuador.

Remarks: Bott considers *Valdivia ecuadoriensis* Pretzmann a synonym of *Zilchiopsis emarginatus* (H. Milne Edwards, 1853). However, the gonopod of our specimens is completely different from the holotype of *Z. emarginatus*, and does not resemble any of the species examined by Bott. In accordance with Bott's classification and key, we place Pretzmann's species in *Zilchiopsis*.

Valdivia serrata White, 1847

Figs. 11 and 12

Valdivia serrata White, 1847, p. 31.

Trichodactylus (*Valdivia*) *serrata.* Rathbun, 1906, p. 49, Pl. XVII, Fig. 4; Coifmann, 1939, p. 94; Holthuis, 1959, p. 210.

Valdivia (*Valdivia*) *serrata.* Pretzmann, 1968b, p. 72; Schmitt, 1969, p. 98, Fig. 2, a–e.

V. (*V.*) *serrata serrata.* Bott, 1969, p. 39; Pl. 6, Fig. 11a; Pl. 19, Fig. 41; Text Fig. 1, p. 11.

Description: Anterolateral buccal angle without teeth or spines, bearing indistinct tubercles.

Third to fifth segments of abdomen of male and female fused.

Gonopod margin and tip curved laterad, twisting slightly so that when marginal surface is viewed, margin disappears behind medial side; gonopod narrowing at tip; strong lateral patch of spines, fine setae on mesial surface; small lateral apical tuft of setae, directed apically; prominence bearing marginal setae well marked.

Description, including color, otherwise as in Rathbun (1906), Holthuis (1959), and Bott (1969).

Material Examined: Venezuela: Alto Caño Rueda, Atures, 22 km from Puerto Ayacucho, Territorio Amazonas; 30 October 1965, Pablo Anduze; 1 male, cb. 36.5 mm, cl. 32.0 mm (MB).—Costa de Iguapo, Cano Iguap. Territorio Amazonas, 450 m altitude; 1 March 1968; Juan A. Rivero; 1 female, cb. 37.4 mm, cl. 33.7 mm. Ecuador: Loreto, foothills of Mount Sumaco, Provincia Napo, 450 m altitude; June 1968; Manuel Olalla; 2 males, cb. 44.0, 37.9 mm, cl. 39.2, 33.6 mm. Colombia: Rio Orteguazá near Venecia, Caquetá, Amazon drainage; March 1966; collector unknown, received from Dr. M. D. Little; one male (40.6–35.2–25.3–13.8) (TU-6092).—Puerto Limón, Rio Caquetá, Amazon drainage, Depto. Putumayo; 17 August 1968; collector unknown, received from Dr. M. D. Little; one male (43.7–37.7–25.8–14.8) (TU-6179).—Rio Arara, Leticia, Depto. Amazonas; 22 August 1969; collector unknown, received from Dr. M. D. Little; 2 males (56.4, 41.8–48.4, 36.1–33.3, 25.8–18.4, 15.0) (TU-6188).

Type and Distribution: The type locality of *Valdivia serrata* is unknown; it has a wide distribution in the Amazon drainages of Venezuela, Colombia, and Ecuador, as well as the Guianas and Brazil.

Remarks: Pretzmann described two new subspecies of *V. serrata.* Bott described two new subspecies, and in addition considered *Sylviocarcinus latidens* A. Milne Edwards, 1869, to be a subspecies of *V. serrata.* All of our specimens are placed under *Valdivia serrata*, because of the undoubted variability of the species, and because there does not appear to be sufficient material available to adequately support the proposed classification.

Valdivia venezuelensis Rathbun, 1906

Figs. 13 and 14

Trichodactylus (*Valdivia*) *venezuelensis* Rathbun, 1906, p. 47, Pl. XVII, Fig. 10.

Holthuisia venezuelensis. Pretzmann, 1968b, p. 74.

Valdivia (*Forsteria*) *venezuelensis venezuelensis.* Bott, 1969, p. 37, Pl. 5, Figs. 9a, b.

Valdivia (*Forsteria*) *venezuelensis edentata* Bott, 1969, p. 38, Pl. VI, Figs. 10a, b, Pl. XIX, Fig. 40.

Trichodactylus (*Valdivia*) *ornatifrons* Pretzmann, 1968, p. 3.

Valdivia (*Valdivia*) *ornatifrons.* Pretzmann, 1968a, p. 71.

Description: Margin of front straight, tuberculate; anterolateral border of carapace with four teeth, including orbital, decreasing in size posteriorly. In large males, carapace teeth become smooth tubercles. Inferior orbital margin with large, blunt tooth on internal angle; rest of margin with blunt

teeth or tubercles; crest of anterolateral buccal angle with poorly defined tubercles.

Chelipeds strongly unequal. Upper border of merus with sharp well-defined spine, in some specimens becoming small or obsolete; inferior internal margin with sharp spine or tubercle. Upper interior margin of carpus with blunt tooth. Chela deep, flattened laterally; in large males, gaping with propodus extending beyond dactylus, strongly hooked at tip.

Third to fifth abdominal segments fused in both male and female. Proximal margin of telson distinctly narrower than distal margin of sixth abdominal segment.

First gonopod of male very broad at base, narrowing abruptly to constriction about two-thirds distance from base to tip; margin and tip curving laterad, margin twisting in mesial direction, emerging at tip on anterior surface; strong lateral protuberance near tip, bearing heavy spines; marginal process bearing setae very conspicuous, well-defined; lateral surface heavily setose on proximal two-thirds. Second gonopod about same length as first.

Remarks: Examination of a large series of specimens from the type locality of *Valdivia ornatifrons* Pretzmann shows that this species is not distinguishable from *Valdivia venezuelensis*, and is based on characters which fall within the range of variation of the latter species.

Valdivia (*Forsteria*) *venezuelensis edentata* Bott, 1969, is based on a large male of *Valdivia venezuelensis*. The peculiar shape of the major chelae and absence of teeth on the anterolateral margin of the carapace is a normal condition of large males of this species. The type locality is given only as "Bolivia". We are of the opinion that this is an error for "Bolivar", a state in Venezuela.

Color: Carapace and pereiopods covered with small, irregular red spots, becoming smaller and more numerous on the H-shaped depression in the gastric region of the carapace, and the cardiac region, and larger and sparser on the major chelae. The chelae in large males becomes white and devoid of spots except on the dorsal edge of the propodus.

Size: Largest male; 47.7–45.4–32.8–21.2. Smallest male without carapace teeth; 34.4–32.1–24.9–16.5 (the major chela was missing in this specimen, but was probably not of the "large male" configuration): largest female; 49.1–44.4–31.7–21.1.

Material Examined: Venezuela: Paraima, Estado de Guarico; 31 March 1950; 1 ovig. female (MB).—Rio Carmen de Cura, 5 km SW of the town of Carmen de Cura, Estado de Aragua; 6 April 1955; F. Martin; 1 immature female (LS 470).—Rio Cura, near the town of Carmen de Cura, Estado de Aragua; 12 February 1954; C. J. Rosales; 1 male (LS 515).—Rio Taguay, Estado de Aragua; 12 December 1967; Juan Pulido; 3 males, 1 spent female; 1 young female.—Cano Los Caballos, Rio Orinoco, Estado de Bolivar; 26 December 1949; A. Maurois; 2 ovigerous females (LS 53).—Rio Chiviripa, between La Urbana and Caicara, Estado Monagas; April 1958; G. Medina; 1 spent female (MB).—Venezuela (without other data); 1 spent female.—Rio Guarapiche, Caicara, Estado Monagas; June 1952; coll., F. D. Smith; 1 male (USNM-119882).—Same locality; 28 males, 22 females, one ovigerous (the largest female).

Type and Distribution: Rathbun designated two females from the Orinoco River as cotypes. She added two males and some immature females from a tributary of the Apure near the Venezuelan Andes, and a female from the Venezuelan "llanos". From our records the species seems to be distributed widely in the Venezuelan llanos, and throughout the Orinoco River basin.

Dilocarcinus (*Dilocarcinus*) *niceforei* (Schmitt and Pretzmann, 1968)

Figs. 15 and 16

Trichodactylus (*Valdivia*) *niceforei* Schmitt and Pretzmann, 1968, p. 6.

Valdivia (*Rotundovaldivia*) *niceforei*, Pretzmann, 1968b, p. 73; Schmitt, 1969, p. 93, Fig. 1.

Valdivia (*Rotundovaldivia*) *niceforei cucutensis* Pretzmann, 1968b, p. 73.

Description: Carapace very convex anteriorly-posteriorly, moderately convex laterally; surface with deep impressions or sulci. H-shaped depression of cardiac region poorly marked. Surface covered with small papillae, closely spaced, barely visible to naked eye; also large punctae. Front strongly bilobed, space between lobes bearing two to five median teeth, with additional small projections or papillae; holotype with two teeth; holotype of *V. n. cucutensis* with eight teeth.

Anterolateral border of carapace with eight spines including orbital; gap between first

and second teeth larger than rest; in *V. n. cucutensis* orbital tooth slender, sharp; in remaining specimens sharp to blunt. Inferior margin of orbit with 5 to 8 spines, diminishing in size laterally. Crest of anterolateral buccal angle with 5 or 6 spines.

All abdominal segments free in both males and females.

Lower margin of ischium with large spine in smaller specimens; lower margin of merus with three median and one terminal spine; internal margin with one median spine; upper margin with one distal spine. Carpus with large spine on internal margin; smaller spines on external and upper margins near articulation of palm. Upper border of propodus with small spine near articulation of dactylus. Ischium spine absent in larger specimens; spines on lower margin of carpus become small papillae, terminal spine becomes triangular tooth; spines of outer and upper margins of carpus and upper border of merus become ill-defined tubercles.

Base of gonopod broad, curving very strongly laterad, just distal to abrupt narrowing of broad base. Projection bearing marginal setae prominent, sharp. Tip of gonopod with rounded expansion; distal part bearing lateral and mesial row of prominent spines, recurved at different angles, irregular in appearance.

Material Examined: VENEZUELA: Rio El Quebradon, near Aguas Calientes, Estado de Zulia; 7 May 1965; F. Majo; 1 male (MB). COLOMBIA: Cucutá, Norte de Santander; collection dates unknown; Br. Niceforo Maria; 3 males, 3 females; USNM 125400, 125401, 125402, 125403, 125404, 125117.

Type and Distribution: The holotype and only specimen of *Valdivia niceforei niceforei* previously reported is a male from Pamplona, Colombia. The holotype and only specimen of *Valdivia niceforei cucutensis* is a male from Cucutá, Colombia. The city of Pamplona is located 2500 m above sea level. Since Trichodactylidae are normally found at altitudes below 500 m, we assume that the crabs were collected in or near the Rio Pamplona, near the city. Since Pamplona and Cucutá are located only 50 km apart, and only two specimens from the region were examined, we do not recognize the subspecific status of these specimens. Schmitt (1969, p. 68) comes to the same conclusion.

The Rio Pamplonita drains into Lake Maracaibo through the Rio Catatumbo. The Venezuelan material comes from small creeks which also drain into Lake Maracaibo; therefore, it appears that the species is restricted to the Lake Maracaibo drainage.

Dilocarcinus dentatus (Randall, 1839)

Figs. 17 and 18

Orthostoma dentata Randall, 1839, p. 122, Pl. V, Figs. 1, 3.

Trichodactylus (Dilocarcinus) dentatus. Rathbun, 1906, p. 65, Pl. XVIII, Fig. 4; Holthuis, 1959, p. 414, Figs. 50, 51; Chace and Hobbs, 1969, p. 152, Fig. 44.

Dilocarcinus dentatus. Pretzmann, 1968b, p. 75.

Poppiana dentata. Bott, 1969, Pl. 11, Figs. a, b, Pl. 20, Fig. 50.

Description: Carapace very convex in both directions; front bilobed, armed with 16 to 21 small spines; anterolateral margin of carapace bearing 10 small, close-set teeth including orbital (9 in one female from Calabozo); gap between second and third tooth greater than between other teeth. In some males, teeth may become semicircular lobes. Inferior orbital border armed with 7 to 11, usually 9, spines, buccal crest armed with 5 to 8, usually 6, spines. Carapace covered with numerous small, approximately circular elevations.

Internal angle of merus of chelipeds with strong tooth; dorsal and ventral angles with small, sharp, distal spines. Carpus with very large spine on inner border. Upper border of propodus with small sharp spine or tubercle.

Abdominal segments 4–6 fused in both male and female.

First male gonopod curving slightly laterad; margin emerging on anterior surface; prominence bearing marginal setae poorly marked, but setae long and conspicuous. Lateral teeth at tip sparse and moderate in size; mesial teeth denser, smaller; strong distal tuft of setae near tip on mesial surface, emerging from a small pit.

Color: The small protuberances of the carapace seen under the microscope, are colored red to dark brown. In life the color appears to be light brown or cream colored.

Size: Measurements of five males from Caicara are as follows: cb., 56.5, 46.0, 45.1, 44.4, 43.7; cl., 45.8, 35.9, 35.7, 35.8, 35.0; fow., 34.4, 28.1, 28.0, 28.2, 27.9; ft., 22.3, 18.2, 17.9, 17.1, 17.1.

Material Examined: Venezuela: Rio Aro, La Aparicion, Estado de Portuguesa; 29 August 1955; Fmx. Martin; 1 female (LS).—Hacienda La Herreria, La Aparicion, Estado de Portuguesa; 22 August 1955; 3 males.—Quebrada Caramacata, 2 km N Apartaderos, Estado de Cojedes; 17 October 1949; L. Ciferri; 1 male, 2 females.—Naguanagua, near Valencia, Estado de Carabobo; 7 November 1965; F. Rumbos; 1 male.—East of San Fernando de Apure. Estado de Apure; 20 June 1951; L. Rivas; 1 female (LS 334).—Hato Piritu, Calabozo, Estado de Guárico; 100 m altitude; 2 January 1963; F. Tamayo; 2 males, 1 with carapace broken, 1 female.—Rio Guárico, 6 km from El Sobrero, Estado de Guárico; A. Fernandez-Yepez; 2 males, 5 females (LS 42).—Espino, Estado de Guárico; L. Klisans; 1 female, 1 immature male. —24 km SSE Calabozo on road to Cazorla, Estado de Guárico; 27 Nov 1966; N. R. Foster, J. S. Ramsey, E. Hoigne; 3 males, 2 females (TU-6220).—Temporary pond 18 km SSE Calabozo on road to Cazorla, Estado de Guárico; 27 Nov 1966; N. R. Foster, J. S. Ramsey; E. Hoigne; 1 male, 1 female (TU-6221).—Quebrado Barbacoas, Estado de Aragua; 12 September 1967; Juan Pulido; 1 female.—Pardillal, Estado de Guárico; October 1952; 1 female (MB).—Isla Chivera, Delta del Orinoco, Territorio Delta Amacuro; 15 December 1952; L. Pojan; 1 male (LS 297).—Cano Onoto, El Callao, Estado de Bolivar; 1 male, 1 female.—Rio Guarapiche, near Caicara, Estado Monagas; 8 September 1968; A. E. Esteves; 5 males.

Type and Distribution: The type specimens are three males and one female from an unknown locality. Holthuis (1959) restricted the type locality to Paramaribo, Surinam. Pretzmann (1968b) described two subspecies, *D. d. cayennensis* from Cayenne, and *D. d. trinidadensis* from Trinidad.

Dilocarcinus (*Dilocarcinus*)
medemi new species
Figs. 19–20, 23

Description: Carapace strongly arched anteriorly and posteriorly, moderately arched laterally; surface finely granulated. Anterior border of front bearing 13 spines (two broken in holotype); suborbital margin of holotype bearing seven spines on each side; paratype with six on each side; buccal crest with five spines; anterolateral border of carapace with eight spines including the orbital. All spines sharp, conical; no gradation into tubercles.

Major chela with alternating large and small teeth on cutting edge of propodus and dactylus; proximal tooth of dactylus large, small tooth just inside large terminal tooth. Propodus bearing dorsal spine at base of dactylus. Distal part of carpus bearing three dorsal spines, median and outer spines small, inner spine very long, curved outward. Merus with long, slender, curved dorsal spine; outer margin with three small, sharp spines (two in paratype), with small tubercle proximal to spines, grouped near center of merus; inner ventral angle with large spine in center, small spine at anterior corner.

Abdominal segments 3–6 fused in male, sides of abdomen curved, narrowing along segments 5–6, broadening at fusion of segment 6 and telson; sides of telson slightly concave.

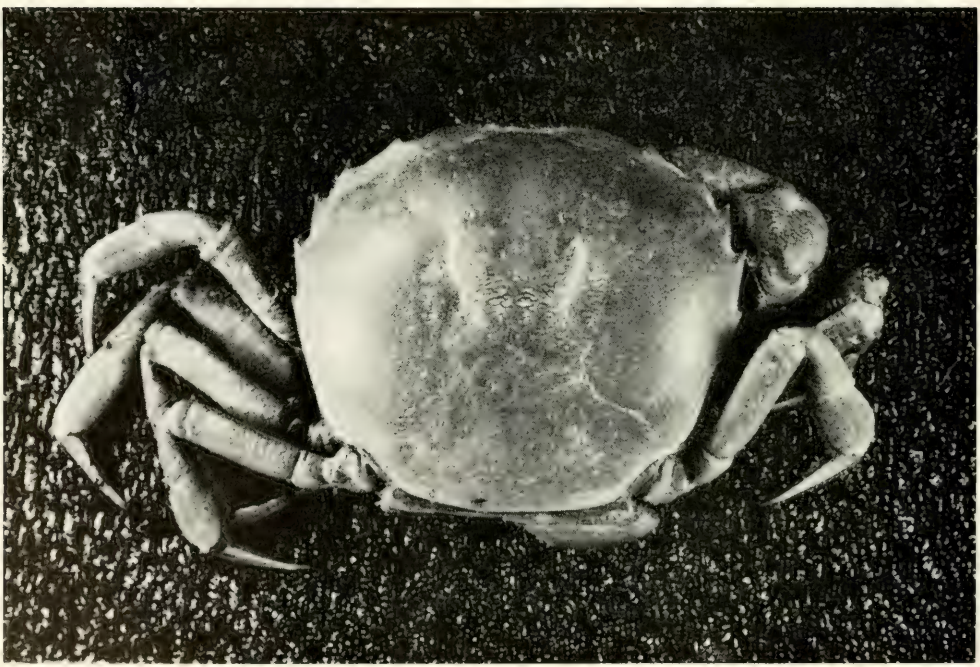
Gonopod curving slightly laterad, narrowing abruptly at about midpoint of distal segment of gonopod; sides nearly parallel in distal portion, with slight expansion at tip. Distal spines small, conical; no apical tuft of setae. Lateral process at tip hook-shaped, slightly exceeding mesial process.

Size: Holotype: cb. 39.0 mm; cl. 31.0 mm; fow., 24.6 mm; ft., 14.2 mm. Paratype: cb. 39.0 mm; cl. 30.9 mm; fow., 25.0 mm; ft., 14.3 mm.

Material Examined: Colombia: Quebrada Tinajon, near Montería, tributary of the Rio Sinú, Dept. Córdoba; 18 April 1962; C. Z. Valasques and R. Comacho; two males.

Type and Distribution: Both specimens are deposited in the United States National Museum; the holotype (USNM-139122); the paratype (USNM-139123). Known only from the type locality.

Remarks: The following comparison is with *Dilocarcinus dentatus* from Venezuela. In *D. dentatus*, the gonopod curves and diminishes in size gradually, without the abrupt narrowing of *D. medemi.* The marginal process is not as prominent in *D. medemi* as in *D. dentatus*, and in the latter species there are very few long setae, except on the marginal process. In *D. dentatus* there is a prominent lateral tuft of stiff setae just proximal to the tip of the gonopod, and the margin curves around to the cephalic surface. The gonopods of the two species are entirely different, at a level which could be considered generic or subgeneric, and illustrates a common problem in Trichodactylidae, where there is a strong tendency toward parallelism or convergence in carapace characters, while the gonopods diverge strongly.



Figures 21–22. 21, *Sylviocarcinus gigas*, paratype male, carapace breadth 88.2 mm; 22, *S. gigas*, paratype female, carapace breadth 61.7 mm.

Figure 23. *Dilocarcinus medemi*, holotype male.

The carapace armature in the two species is very similar, the main difference being that the spines in *D. medemi* are sharper and more slender, particularly on the lower orbital border. The major chelae are differently shaped, being much deeper in *D. dentatus* than in *D. medemi*, with the fingers of the latter proportionately shorter.

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NOTES ON SKELETAL VARIATION, TOOTH REPLACEMENT, AND CRANIAL SUTURE CLOSURE OF THE PORCUPINE (*ERETHIZON DORSATUM*)

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Abstract

Variation occurs in many of the cranial elements and in the pattern of the cranial foramina of the porcupine *Erethizon dorsatum*. Tooth eruption and replacement are completed by the end of the second year of life with all molars erupting by the age of 6–8 months and the deciduous premolars replaced between 12–18 months later. Sutures of the skull close in a predictable pattern and closure is correlated with age. Variation in the vertebral number is considerable, with the thoracolumbar region varying from 19–23. The presence of one major sesamoid in the carpals and two in the tarsals has led to some confusion in the terminology used by previous writers.

Introduction

Information on the osteology of the porcupine (*Erethizon dorsatum*) is not plentiful in the literature. Only Swena and Ashley (1956) have discussed the skeleton at some length. This paper offers new information, particularly with respect to variation, and discusses certain points which are in disagreement with earlier writers. The sequence of suture closure and the timing of tooth eruption and replacement are briefly outlined.

Methods and Materials

For this study 186 cleaned skulls and 26 complete skeletons were examined. Data presented here are largely qualitative and are intended to show areas in which variation was easily noticed. In studying vertebral variation, only complete skeletons which were either articulated or semi-articulated in such a manner that all vertebrae could be accounted for were used.

Deciduous and permanent teeth were distinguished by observation of the root position in the upper premolars and by occlusal patterns in the lower premolars. Several X-ray photographs were taken on doubtful specimens, but this was usually unnecessary. Permanent premolars were generally larger than deciduous premolars.

Suture closure was determined by the amount of ossification along a suture. A suture was considered closed if one-half or more of its length was ossified.

Specimens examined were from collections at: University of Nebraska (ZM); University of Kansas Museum of Natural History (KU); United States National Museum (USNM); the American Museum of Natural History (AMNH); Southern Illinois University (SIU); University of Arizona (UA); Chicago Field Museum of Natural History (FMNH); National Museum of Canada (NMC); Peabody Museum Yale University (YPM); University of Utah (UU); as well as two personal specimens (JFS). A complete list of the specimens examined is available in the manuscript on file at the Southern Illinois University Library.

Acknowledgments

I would like to express my appreciation to Drs. Howard J. Stains and E. C. Galbreath for advice throughout this study. The Zoology Department at Southern Illinois University provided financial aid, research space, and equipment. Mr. Carl Frailey prepared the original figures from which those in Figure 2 of this paper were taken.

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Osteological Variations and Observations

THE SKULL

Frontal.—The frontals often bear raised areas over the orbits which appear to vary with age. These bulges are more pronounced in older males than in females although they can be equally developed in both sexes. Those animals in the Western United States, particularly *Erethizon dorsatum epixanthum*, tend to have larger bulges than any of the other subspecies.

Parietal.—The coronal suture (anterior suture) separating the parietals and frontals varies individually in the specimens examined. In some skulls the coronal and sagittal sutures intersect at nearly 90°, while in others they may form an inverted "V" where they meet. A complete gradation in variation is seen between these two extremes.

Interparietal.—The interparietals are usually triangular, with the base along the occipital suture on the lambdoidal ridge. Variation in shape of the interparietals is caused by the formation of wormian bones, which may number as many as eight, along the sagittal suture. These wormian bones may also continue forward along the sagittal suture into the parietal and frontal area.

Occipital.—The external occipital protuberance projects posteriorly as an apparent extension of the sagittal crest through the lambdoidal ridge. This is also a function of age, with the protuberance being largest on the oldest individuals.

Squamosal.—The posterior margin of the squamosal may articulate with the occipital along the lambdoidal ridge or, less commonly, with a lateral extension of the parietal.

Swena and Ashley (1956, Fig. 1) indicate that a separate temporal bone and a distinct squamosal exist in the porcupine. Romer (1963) points out that when a temporal bone exists, it is a compound structure composed of the fused squamosal, periotic, and auditory bulla (tympanic). In the specimens which I have examined, fusion of these elements has not occurred except in several extremely old specimens.

Swena and Ashley illustrate two bones in the squamosal area and identify the anterior bone supporting the zygoma as the squamosal, and the posterior bone over the bulla as the temporal. This is probably the result of a second center of ossification in the squamosal area. I observed one specimen (AM63759) which showed two "squamosals" that was undoubtedly the result of two centers of ossification in the squamosal area.

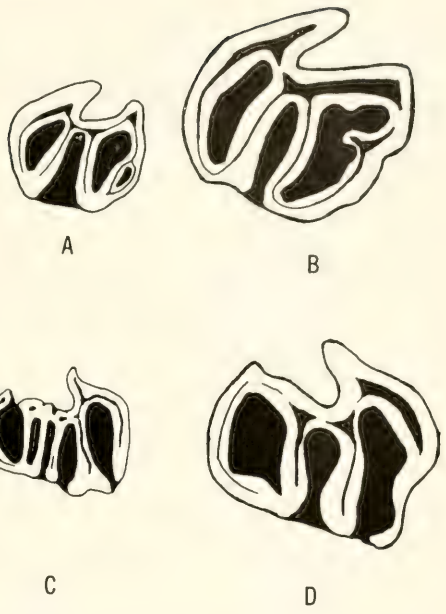

Figure 1. Deciduous and permanent premolars of *Erethizon dorsatum*. A. dp^4. B. p^4. C. dp_4. D. p_4. All figures 4, 5×.

Lacrimal.—In most mammals the lacrimal bone occupies the anterodorsal margin of the orbit. The porcupine apparently lacks this bone since few of the specimens possessed a suture which could be identified as a lacrimal suture. It is possible that this bone is formed and fused to the maxillary during embryonic development; however, Struthers (1927) does not indicate the presence of this bone in the early embryology.

Jugal.—The jugal bone, zygomatic process of the maxillary, and zygomatic process of the squamosal form the zygomatic arch in the porcupine. The arches are usually slightly asymmetric, with the left arch extending further posteriorly than the right. This usually results in a thinning and more pronounced recurving of the left zygomatic process of the squamosal.

Cranial foramina.—The cranial foramina of the porcupine and other rodents have been summarized by Hill (1935). Some addi-

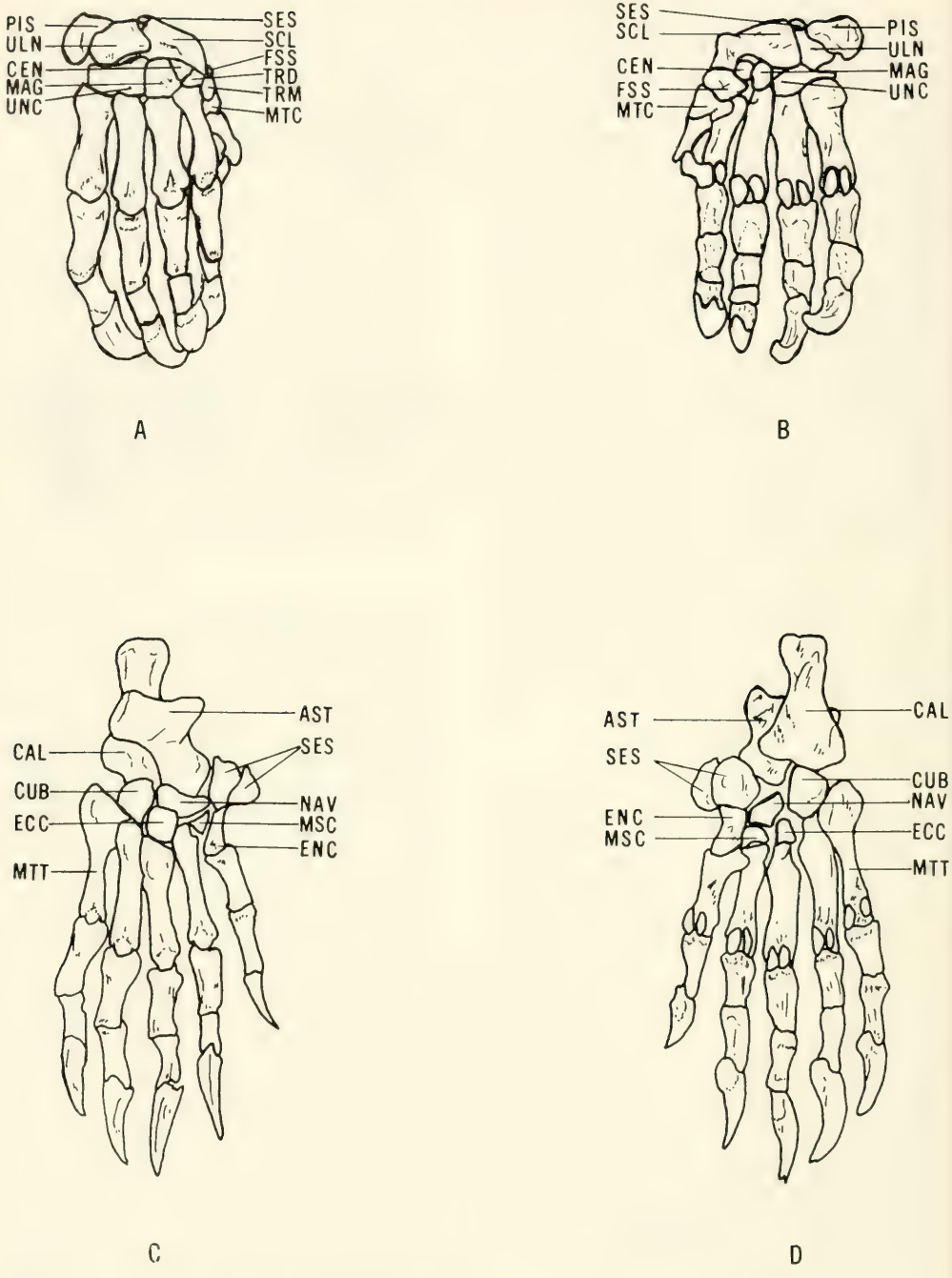

Figure 2. Carpals and tarsals of the porcupine *Erethizon dorsatum*. A. Dorsal view of the carpals. B. Ventral view of the carpals. C. Dorsal view of the tarsals. D. Ventral view of the tarsals. All figures 1×. Abbreviations. AST.—astragalus, CAL.—calcaneum, CEN.—centrale, CUB.—cuboid, ECC.—ectocuneiform, ENC.—entocuneiform, FSS.—falciform sesamoid, MAG.—magnum, MSC.—mesocuneiform, MTC.—metacarpal, MTT.—metatarsal, NAV.—navicular, PIS.—pisiform, SCL.—scapholunar, SES.—sesamoid, TRD.—trapezoid, TRM.—trapezium, ULN.—ulnare, and UNC.—unciform.

tional information can be added here concerning variation in these foramina.

The masticatory and buccinator foramina are extremely variable. According to Hill, the two are separate; however, I found that confluence of these foramina is common.

The squamosal foramen is absent in the porcupine according to Hill; however, I found it in the majority of my specimens. In some individuals the foramen was absent, or present on one side of the skull only. The interpremaxillary foramen (Hill, 1935) is not located in the typical position in the porcupine. Hill describes this foramen in other rodents as being located immediately posterior to the incisor teeth in the premaxillary. In the porcupine it is located immediately anterior to the palatine foramina and may be paired in some individuals.

The nasolacrimal canal of the porcupine is well developed although somewhat unusual in its pathway according to Hill. In some of the specimens I examined, the canal was either completely lacking or represented by a small depressed area in the maxillary.

Tooth eruption and replacement.—According to Taylor (1935) most porcupines are born in April and May with occasional births occurring later in the summer. The tooth complement at birth includes an incisor, deciduous fourth premolar, and first molar in each tooth row.

The second molar begins to erupt in August of the first year, but may not appear until October. Eruption is complete by October in most cases. The final molar appears in mid-winter of the first year.

Following the eruption of the molars, a period of 12–18 months passes before the permanent premolar replaces the deciduous premolar. Premolars in the process of replacement were observed in ten specimens; six were in mid-winter of the second year and four were starting their third summer of life (Sutton, 1969).

Differentiation between permanent and deciduous premolars (Fig. 2) in the maxillary was accomplished by examining the visible root areas in the prepared skulls. The DP^4 and P^4 are identical in occlusal pattern; however, the DP^4 differs in the degree of spreading of the roots to allow for development of the P^4 in the maxillary. DP_4 and P_4 are different in occlusal pattern with DP_4 being narrower and composed of six enamel bands, while P_4 is composed of four (occasionally five, KU62282).

TABLE 1. Suture closure. Percentage and total number of animals with specific sutures closed. Based on 184 animals.

Suture	Percent	Number closed
Occipital-parietal-interparietal	88.0	162
Interparietal-interparietal	84.8	156
Parietal-interparietal	77.7	143
Parietal-parietal	60.9	112
Parietal-frontal	39.1	72
Frontal-frontal	37.0	68
Frontal-squamosal	31.5	58
Parietal-squamosal	31.0	57
Nasal-nasal	12.5	23
Premaxillary-maxillary	08.7	16
Frontal-nasal	05.4	10
Jugal-zygomatic of squamosal	04.9	9
Frontal-maxillary	04.3	8
Zygomatic of maxillary-jugal	04.3	8
Frontal-premaxillary	02.0	4
Nasal-premaxillary	00.5	1

Suture closure.—Suture closure was examined and recorded in 184 skulls. Sixteen skulls with no sutures closed are presumed to be from animals less than four months old. Table 1 lists the sutures (identified by the bones lying on either side), the percentage, and the total number of specimens with that suture closed. The apparent groups into which they fall presumably correspond to yearly growth (see Sutton, 1969). These data were also submitted to multilinear regression (Kelly *et al.*, 1969) to establish correlation values. The relationships which resulted corresponded closely to those represented by the percentage system (Table 1) and need not be repeated here.

Four sutures close during the first year of life. These include: occipital-parietal-interparietal; interparietal-interparietal; parietal-interparietal; and parietal-parietal. These sutures are associated with the closure of the braincase and probably reflect completion of brain development.

Second year individuals are characterized by continued completion of skull growth in an anterior direction. Skull width is complete (except zygomatics) and the skulls are approaching adult size. The sutures involved include: parietal-frontal; frontal-frontal; frontal-squamosal; and parietal-

squamosal. The nasal-nasal suture follows these in percent of closure, but is seldom completely closed. Ossification begins at the rear or base of the nasals and progresses anteriorly. This suture and the remaining sutures (with the exception of the zygomatics) are all related to the nasal area and close slowly throughout the remainder of the life of the animal. This probably reflects a slow widening and lengthening of the skull in the nasal area accounting for most of the variation in skull length of adult animals.

From this point on closure of the remaining sutures is slow, with the zygomatic of the squamosal-jugal and zygomatic of the maxillary-jugal closing very late in the life of the animal.

THE POST-CRANIAL SKELETON

Vertebral column.—Variation in the number of vertebrae has been reported for many animals, especially in the caudal region where loss of vertebrae is common. Occasionally variation is reported within the thoracolumbar region, but this usually results in a nomenclatorial problem since the loss of a rib pair is generally the source of the variation. A few animals do vary in the total number of thoracolumbar vertebrae, but this variation usually involves a difference of only one vertebra, seldom more.

Swena and Ashley (1956) indicate the vertebral formula of the porcupine to be: c_7 th_{15-16} l_7 s_4 ca_{14}; whereas Gupta (1965) indicates that the formula is c_7 th_{15-16} l_5 s_{3-4} ca_{18}. Gupta also maintains that when 16 thoracics are present, only three sacrals will be found. In this study four sacrals were consistently observed with the fourth sacral connected to the ischial tuberosity of the innominate by a ligament.

Thoracic vertebrae and the number of associated pairs of ribs varies from 14–17. Occasional skeletons exhibit a small rib (25 mm or less) on the last thoracic vertebra. This small rib may be normally articulated on both sides, or on one side only with fusion to the vertebra on the other. The vertebra in question was assigned to the thoracics when this situation was found.

Lumbar vertebrae vary in number from five to six, and variation is not correlated with an increase or decrease in thoracic number as Gupta indicated concerning the thoracic-sacral situation. I found no specimens with seven lumbars as indicated by Swena and Ashley, nor any with 18 caudals as indicated by Gupta.

The total number of thoracolumbar vertebrae varies from 19–23. Table 2 presents the vertebral counts and identification of the specimens involved in the study. Several specimens did not have the caudal region intact, and these figures are omitted.

Carpals and metacarpals. Figures 2a and 2b. Metacarpal I is extremely reduced. The sesamoids, which are obvious on the metacarpal-phalanx arcticulations of other digits, are extremely reduced, but still present.

Swena and Ashley (1956, Figs. 26 and 27) report the existence of a greater multangular and trapezium in the carpus of the porcupine. These two names are synonymous. That which they identify as the greater multangular is in reality a sesamoid. Howell (1926) describes a similar sesamoid in the wood rat and applies the term falciform sesamoid to the bone.

Tarsals and metatarsals. Figures 2c and 2d. The interpretation of the tarsal elements of the porcupine appears to be particularly troubling due to the presence of two sesamoids on the medial margin of the foot. Hill (1937) recognized an extra sesamoid in the foot of the pocket gopher and termed it the *os tarsale mediale.* I have not attempted to name either of the two elements, but have chosen to refer to them as sesamoids until further anatomical work can be done.

I do not agree with Swena and Ashley in naming these elements the tibiale and the first cuneiform for several reasons. The internal sesamoid articulates with the head of the astragalus internally, and externally with the other sesamoid. It articulates with the entocuneiform distally. This internal sesamoid is that referred to as the tibiale by Swena and Ashley. The tibiale is not found in mammals, but is one of the primitive reptilian bones forming the astragalus (for example, Peabody, 1951, in *Captorhinus*). In reality this sesamoid probably represents part if not all of Hill's *os tarsale mediale.*

The external sesamoid is called the first cuneiform (entocuneiform) by Swena and Ashley. If this bone is to be considered an entocuneiform, the remaining tarsal elements are indeed extremely modified. Swena and Ashley indicate that metatarsal I is in the position of the entocuneiform and is ex-

Table 2. Vertebral variation in the porcupine *Erethizon dorsatum*. Abbreviations: Ca., Caudal; L., Lumbar; and Th., Thoracic.

Number	Th.	Th.–L.	Ca.	L.	Sex	Location	Subspecies
KU 9406	17	23	17	6	M	Kan.	*E. d. bruneri*
KU 12098	16	22	15	6	F	Captive	*E. d. dorsatum*
KU 8266	16	21	16	5	?	N. M.	*E. d. couesi*
KU 15859	16	21	16	5	F	Wyo.	*E. d. epixanthum*
AMNH 70015	16	21	15	5	M	?	*E. d.* ?
SIU 0-597	16	21	14	5	F	N. M.	*E. d. couesi*
KU 6645	16	21	—	5	?	N. M.	*E. d. couesi*
ZM 2392	16	21	—	5	?	Neb.	*E. d. bruneri*
KU 7859	15	21	16	6	M	Ariz.	*E. d. couesi*
JFS 4	15	21	—	6	M	Wisc.	*E. d. dorsatum*
SIU 0-471	15	21	15	6	M	Colo.	*E. d. bruneri*
KU 73917	15	21	16	6	F	N. M.	*E. d. couesi*
AMNH 70422	15	21	15	6	M	?	*E. d.* ?
USNM 88619	15	21	15	6	F	N. Y.	*E. d. dorsatum*
ZM 2129	15	21	—	6	M	Wyo.	*E. d. epixanthum*
AMNH 63759	15	21	14	6	F	N. Y.	*E. d. dorsatum*
CFM 53733	15	21	—	6	M	?	*E. d.* ?
KU 15860	15	20	16	5	F	Wyo.	*E. d. epixanthum*
JFS 2	15	20	15	5	M	Wisc.	*E. d. dorsatum*
AMNH 70559	15	20	15	5	M	?	*E. d.* ?
USNM 49420	15	20	13	5	M	Wyo.	*E. d. epixanthum*
KU 8264	15	20	—	5	F	Idaho	*E. d. epixanthum*
AMNH 16872	14	20	16	6	F	?	*E. d.* ?
AMNH 147530	14	20	14	6	F	N. J.	*E. d. dorsatum*
CFM 43299	14	20	—	6	M	Wisc.	*E. d. dorsatum*
AMNH 150093	14	19	15	5	M	N. H.	*E. d. dorsatum*

tremely modified to look more like a tarsal element. That which they call metatarsal I is actually the entocuneiform and therefore should look like a tarsal bone. They state further that there are three phalanges in the first digit, and that the small sesamoids found on the ventral surface of the foot at the metatarsal-phalanx articulation are in a different position on the first digit; between the first and second phalanges with the first phalanx being modified to look like a metatarsal. I feel that there is no need to go to such great lengths to explain the tarsal situation. There are two medial sesamoids which may be the result of splitting of the *os tarsale mediale* of Hill, or they may be of separate origin. Further the entocuneiform is found in its normal position between metatarsal I and the internal sesamoid; metatarsal I is not modified to be a tarsal (functionally); and the first digit has only two phalanges and thus does not differ from the basic mammalian phalangeal count of 2-3-3-3-3.

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REVISION OF *LOUTERIDIUM* (ACANTHACEAE)

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ABSTRACT

Louteridium is limited to the New World tropics and shows a preference for steep rocky slopes in wet forests. In the present revisionary treatment the nine species are recognized in two sections: Sect. Tetrandrium comprising the four-staminate *L.* ***brevicalyx***, *L. koelzii*, and *L. chartaceum*; Sect. Louteridium comprising the two-staminate *L. costaricense*, *L. tamaulipense*, *L. conzattii*, *L. parayi*, *L. mexicanum*, and *L. donnell-smithii*.

INTRODUCTION

Louteridium is a New World tropical member of the Acanthaceae, subfamily Acanthoideae, tribe Ruellieae. As treated here, the genus comprises nine woody species, two of which have been described during the course of this study.

The species are poorly known and have been infrequently collected, probably because of the inconspicuous inflorescences, and the difficult terrain in which the plants grow. Thus, specimens from the eight major herbaria housing neotropical collections yielded only one collection of *L. chartaceum*, one of *L. conzattii*, one of *L. costaricense*, one of *L. parayi*, two of *L. brevicalyx*, two of *L. koelzii*, six of *L. tamaulipense* (all from the same population), fourteen of *L. mexicanum*, and forty-three of *L. donnell-smithii*. *L. tamaulipense* was the only species examined in the field.

ECOLOGY

Geographic locations of the species are indicated on Figure 1. Information concerning habitat preference of the genus was obtained from herbarium label data and from personal observation of one population in the field. The reports, though fragmentary, indicate a preference for steep rocky limestone and volcanic slopes in wet tropical forests.

Field Observations: The only population from which collections have been made of *L. tamaulipense* is located near Gómez-Farías, Tamaulipas, Mexico. The habitat at Gómez-Farías is described by Martin (1958) as a tropical semi-evergreen and evergreen forest, and he suggests that this is the northernmost forest of this type. The plants were growing in shade and full sun. There was no apparent difference in the vegetative growth of the plants growing in shade or sun, but those growing in full sun or lightly shaded places were more floriferous. The terrain was limestone, steep and rocky. The plants were sprawling and sending out adventitious roots on the rocks; however, none of these were epiphytic in trees, as reported of *L. parayi* (Miranda, 1954).

Hourly observations were made from 6:00 P.M. on 8 September 1969 to 8:00 A.M. on 9 September 1969. There was no rainfall. The corollas began opening at sunset and began to fall in the early morning. There was no detectable scent from the flowers, and no nectar was found in the gibbous throat of the corolla. The gland located at the base of the ovary had an intensely sweet taste. A hummingbird visited the flowers at dusk and again in the early morning.

Pollinator: Comments as to the adaptive pollinator must be highly tentative because of the lack of information. The position and size of the sex organs suggest a large pollinator such as a bird, with the pollen carried on the dorsal surface of the pollinator.

Some of the characteristics of ornithophilous species cited by Faegri and Van der Pijl (1966) are (1) diurnal anthesis, (2) vivid colors, (3) lip or margin curved back, (4) no odor, and (5) abundant nectar. (1) As

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Figure 1. Distribution of the genus *Louteridium*.

was indicated by my observations, the corolla of *L. tamaulipense* is open at times when hummingbirds are active. (2) As to color, many bird-visited flowers are white (Faegri and Van der Pijl, 1966). In addition, the two species which I consider most advanced on the basis of morphology and distribution have some color. According to herbarium label data, the corolla of *L. mexicanum* is greenish-white tinged with pale lilac inside. There are different color forms of *L. donnell-smithii* which vary from greenish white to dark purple. (3) The revolute condition of the corolla lobes is a characteristic of the genus. (4) The flowers were odorless to me. (5) There is not an abundance of nectar. However, the open flower on the panicle is slightly elevated from the horizontal. In this position, it could catch rain water which would be held in the gibbous throat, dissolving the concentrated sugars around the glandular disc.

In summary, the flowers exhibit some of the generally accepted characteristics of ornithophilous species; and hummingbird visitation has actually been observed by me in one population. No other potential pollinators are known to visit the flower.

Generic Relationships

Literature concerning the Acanthaceae has been summarized by Grant (1955) and, more recently by Long (1970). Watson (1888), Lindau (1895), and Bremekamp and Nannenga-Bremekamp (1948) concur in placing *Louteridium* in the subfamily Acanthoideae. Watson placed the genus in the tribe Ruellieae. Lindau subsequently treated it as the sole genus in the tribe Louterideae. More recently Bremekamp and Nannenga-Bremekamp restored *Louteridium* to the subtribe Ruelliinae of the tribe Ruellieae on the basis that Lindau overemphasized a single character, that of pollen type.

Taxonomic Treatment

LOUTERIDIUM Wats.

Louteridium Wats., Proc. Amer. Acad. Arts 23:283. 1888 (Type species, *Louteridium donnell-smithii* Wats.).

Neolindenia Baill., Bull. Mens. Soc. Linn. Paris 2:851. 1889 (Type species, *Neolindenia mexicana* Baill.).

Shrub or soft-wooded tree, seasonally deciduous at least in some species. Leaves simple, opposite, decussate, estipulate; dark green on upper surface, light green on lower surface; cystoliths present, more prominent on upper surface, particularly along midrib and veins; midrib and veins more prominent on lower surface. Inflorescence a terminal, cymose, bracteate panicle with a pair of cymes arising from each node. Calyx 3-lobed. Corolla somewhat laterally compressed, sympetalous, 5-lobed, contorted (as defined by McLean & Ivimey-Cook, 1956) in bud, 2-lipped with 2 lobes above and 3 below; opening at dusk and falling at sunrise; tube short; throat prominently gibbous. Stamens 2 and coalescent with a sterile filament at the base, or 4 and diadelphous, adnate to the corolla, alternate with the lobes, 6–9.4 cm long; anthers exserted, locules 2, opening longitudinally. Pollen grains spherical, 125–230 μ in diam; periporate; regular or irregular echinoid pectinaceous protrusions through the pores; gemmate; the surface microrugulate. Ovary slightly flattened, 0.4–0.7 cm tall, 0.1–0.2 cm across; sessile on a glandular disc; carpels 2, locules 2; ovules numerous, anatropous in 2 series, placentation axile. Styles 5.6–8.2 cm long. Stigma 2-lobed, exserted, usually slightly beyond the stamens. Fruit a loculicidal capsule, flattened; retinacula falcate, 0.3–0.5 cm long. Seeds discoid to subdiscoid.

Key to the Species

1. Stamens 4, diadelphous ..... Section Tetrandrium (Fig. 2) (2)
1. Stamens 2, each coalescent with a sterile filament ..... Section Louteridium (Fig. 6) (4)

2 (*1*). Calyx lobes lanceolate or ovate, the length less than 3 times the width ..... (3)

2. Calyx lobes linear, the length ca 6 times the width ..... 3. *L. chartaceum* (Fig. 5)

3 (*2*). Calyx lobes equal, lanceolate, without prominent dark longitudinal veins ..... 1. *L. brevicalyx* (Fig. 3)

3. Calyx lobes unequal, ovate, with prominent dark longitudinal veins ..... 2. *L. koelzii* (Fig. 4)

4 (*1*). Calyx lobes equal or subequal and leaflike; dorsal lobe not conduplicate ..... (5)

4. Calyx lobes unequal, not leaflike, dorsal lobe conduplicate ..... (6)

5 (*4*). Inflorescence glabrous, bracts persistent, stigmatic lobes equal ..... 4. *L. costaricense* (Fig. 7)

5. Inflorescence pubescent, bracts caducous, stigmatic lobes unequal ..... 5. *L. tamaulipense* (Fig. 8)

6 (*4*). Bracts of the inflorescence cordate, large and leaflike throughout ..... 6. *L. conzattii* (Fig. 9)

6. Bracts of the inflorescence not cordate, not large nor leaflike throughout (sometimes so at the first node only) ..... (7)

7 (*6*). Plants glabrous; dorsal calyx lobe with a basal pair of globose glands ..... 7. *L. parayi* (Fig. 10)

7. Plants pubescent or puberulent; dorsal calyx lobe not glandular ..... (8)

8 (*7*). Plants puberulent with 1-celled or occasionally 2-celled hairs; stalks of the lateral branches of the inflorescence reduced and compacted throughout, ca 0.2 cm long ..... 8. *L. mexicanum* (Figs. 11, 12)

8. Plants pubescent with several-celled hairs; stalks of the lateral branches of the inflorescence up to 12 cm long at the base, becoming reduced and compacted only at the apex ..... 9. *L. donnell-smithii* (Figs. 13, 14)

Section **Tetrandrium** A. Richardson, sect. nov.

Stamina 4. Corolla alba vel flavo-viridis ca 4.5 cm longa vel brevior; faux aliquantum gibba; lobi apice rotundati longitudine latitudineque aequalibus (Fig. 2). Calycis lobi laminiformes non conduplicati. Nodia alternatim conferta remotaque.

Stamens 4. Corolla white to yellowish-green, ca 4.5 cm or less in length; throat somewhat gibbous; lobes rounded at the apex, length and width ca equal (Fig. 2). Calyx lobes leaflike, not conduplicate. Internodes of the stem reduced, in clusters separated by a single, longer internode or terminated by the inflorescence (stems of *L. brevicalyx* not examined).

Type species: L. chartaceum Leonard.

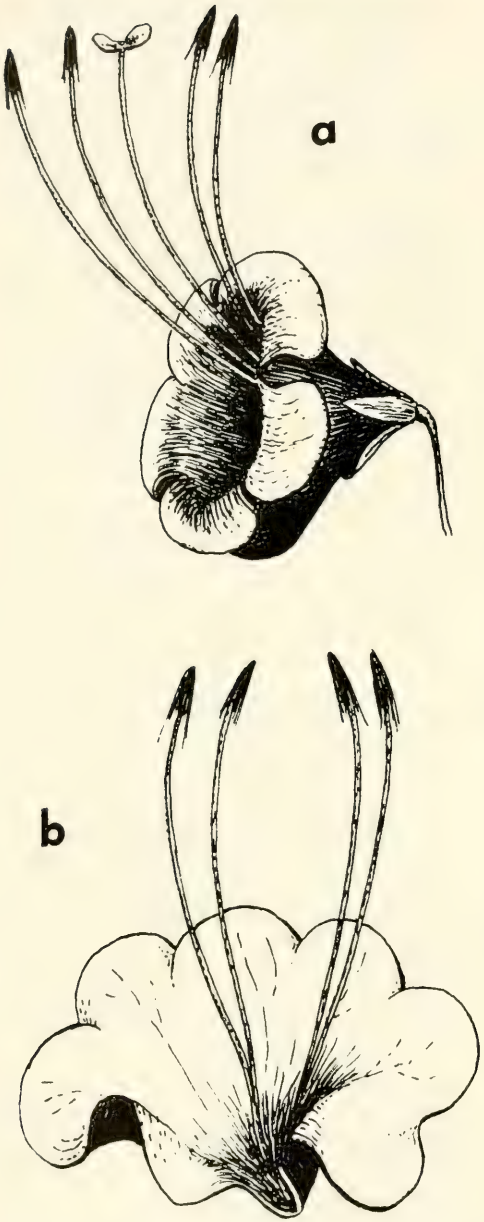


Figure 2. Drawings of *Louteridium brevicalyx* A. Richardson, representative of Section Tetrandrium, by Mr. Geza Knipfer. A. Perianth, from pressed herbarium specimen. B. Corolla laid open.

Presumably the leaves become clustered toward the end of the growing season and are deciduous; before the next foliage-growing spurt the inflorescence appears. Then the branches from the clustered nodes send out rapidly growing shoots with long internodes at first, then clustered leaves.

1. ***Louteridium brevicalyx*** A. Richardson, sp. nov.

Arbor usque ad 3 m alta. Inflorescentia elongata glandulosa. Calyx parvus lobis lanceolatis aequalibus ca 0.5 cm latis, ca 1.2 cm longis. Stamina 4. Fructus magnus ca 0.8 cm latus, ca 4.2 cm longus.

(Holotype US!) Mexico. Michoacán: Aquila, district of Coalcomán, 200 m, 21 Mar 1941, Geo. B. Hinton 15825.

A tree to 3 m tall, viscid, with brittle branches. Foliage unknown. Inflorescence elongate and slender, pubescent with glandular hairs (Fig. 15, E & F); bracts caducous, ca 0.6 cm long, outer surface glandular; stalk of lateral branches up to ca 4 cm long but usually less. Pedicels ca 4.3 cm long. Calyx brown, chartaceous; lobes ca equal, lanceolate, reduced, ca 1.2 cm long, ca 0.5 cm wide and joined at the base for ca 0.2 cm, loosely enclosing the bud. Corolla white; tube ca 0.9 cm long, ca 0.7 cm in diam; throat moderately gibbous, ca 2.2 cm long, ca 2.5 cm across; lobes equal, ca 1.5 cm long, ca 1.5 cm wide, somewhat recurved (Fig. 2). Stamens 4, diadelphous, glabrous; anthers ca 0.9 cm long. Pollen grains 125–210 μ in diam, sometimes with irregular echinoid protrusions. Ovary glabrous. Stigmatic lobes equal, ca 2.5 mm long, ca 2 mm wide. Fruit large, ca 4.2 cm long, ca 0.8 cm wide, retinacula ca 0.4 cm long. Seeds subdiscoid, ca 0.6 cm across, thickened for about 0.5 mm around the margin.

Distribution: Known only from the type locality, cited above (Fig. 1). According to herbarium label, the plants were seen frequently, and were growing only on rock on a cliff, from 200–400 m.

Described from flowering specimens without leaves. *L. brevicalyx* can be quickly identified by its 4 stamens, its equal and reduced calyx lobes, and its large fruits (Fig. 3). The pollen grains often have echinoid protrusions through the pores, but they are irregular in length and in distribution over the surface of the grains; therefore they are easily distinguished from those of *L. donnell-smithii.*

Additional specimen examined: MEXICO. MICHOACÁN: Aquila, district of Coalcomán, 400 m, 24 Mar 1941, Hinton 15843 (US).

Figure 3. Photograph of *L. brevicalyx* A. Richardson, holotype.

Figure 4. Photograph of *L. koelzii* McVaugh & Miranda, holotype.

2. *Louteridium koelzii* Miranda & McVaugh, Anales Inst. Biol. Univ. Nac. Mexico 32: 182. 1962. (Holotype MICH! isotype MEXU) Mexico. Jalisco: Steep rocky mountainsides, on limestone, 8 mi SW of Pihuamo, 500–600 m, 6 Dec 1969, R. McVaugh & W. N. Koelz 1507.

A tree to 6 m tall, the trunk 15 cm in diameter, with stubby, upright branchlets. Leaves entire, glabrous; blades 11–19 cm long, 5.5–9 cm wide, ovate to elliptic, attenuate and curved downward at the apex, the base acute, petiole 2.5–6.5 cm long. Leaf scars prominent, hippocrepiform. Internodes of the stem 0.2–0.3 cm long arranged in clusters separated by a single longer internode 1–7 cm long, or terminated by the inflorescence (Fig. 4). Inflorescence pubescent with several-segmented hairs (Fig. 15, I & J); bracts caducous: stalk of lateral branches of axis reduced, 1 cm or less in length. Pedicel ca 2.5 cm long, pubescent. Calyx pale green with prominent dark longitudinal veins, pubescent on both surfaces, loosely enclosing the bud, lobes ovate, acute at the apex, the base truncate; upper lobe ca 2.4 cm long, ca 1.2 cm wide; lateral lobes ca 1.9 cm long, ca 1 cm wide. Corolla pale green, lightly pubescent; lobes ca equal with rounded tip. Stamens 4, filaments pubescent at the base; anthers ca 0.9 cm long, lightly pubescent. Pollen grains 140–200 μ in diam. Ovary heavily pubescent; style lightly pubescent; stigmatic lobes subequal; upper lobe ca 0.75 mm long, ca 1 mm wide; lower lobe ca 1 mm long, ca 1 mm wide.

Distribution: Known only from the type locality, cited above (Fig. 1). According to herbarium label, it is abundant on steep rocky limestone mountainsides in a high dense forest dominated by *Brosimum.*

Described from specimens in bud only. *L. koelzii* is most easily distinguished from the other 4-staminate species by its unequal, darkly-veined calyx lobes (Fig. 4).

Additional specimen examined: MEXICO. JALISCO: Steep rocky mountainsides, on limestone, 8 mi SW of Pihuamo, 500–600 m, 15 Dec 1959, McVaugh & Koelz 1797 (MICH).

Figure 5. Photograph of *L. chartaceum* Leonard, holotype.

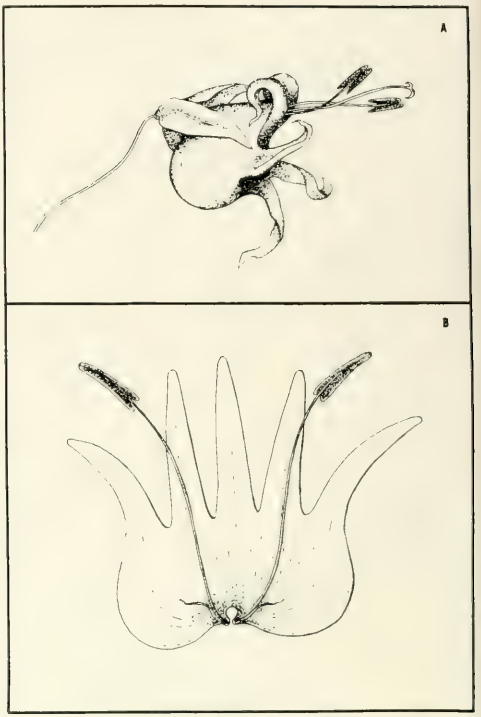


Figure 6. Drawings of *L. tamaulipense* A. Richardson, representative of Section Louteridium, by Mr. Geza Knipfer. A. Pressed flower. B. Corolla laid open.

3. *Louteridium chartaceum* Leonard, Publ. Carnegie Inst. Wash. 461:197. 1936. (Holotype US! Isotypes A! MICH!) British Honduras. Gracie Rock, Sibun River, 24 Mar 1935, Percy H. Gentle 1526.

A woody, glabrous plant. Leaves entire; blade 14.5–18.5 cm long, 4.5–6 cm wide, elliptic, attenuate and curved downward at the apex, decurrent on the petiole; petiole 2.5–4.5 cm long. Leaf scars prominent, hippocrepiform. Internodes of the stem 0.2–0.3 cm long arranged in clusters separated by a single longer internode 1.5–2.8 cm long, or terminated by the inflorescence (Fig. 5). Inflorescence long and slender with few flowers; bracts small and caducous and leaving prominent scars; a pair of small, leaf like bracts sometimes present at the first node of the axis; stalks of lateral branches of axis reduced, 0.1–0.3 cm long. Pedicel 3.2–5.2 cm long. Calyx greenish or brown; lobes equal, chartaceous, linear, acute at the apex, the base truncate, 2.2–2.5 cm long, 0.3–0.4 cm wide. Corolla yellowish-green (according to Leonard), but brown on dried specimens; tube ca 0.5 cm long, ca 0.5 cm diam; throat ca 1.5 cm long, ca 2 cm across; lobes revolute, ca equal, ca 1.3 cm wide at the base, ca 1.3 cm long, rounded at the apex. Stamens 4, filaments minutely puberulent toward the base; anthers ca 0.7 cm long. Pollen grains 140–200 μ in diam. Stigmatic lobes unequal; upper lobe ca 1 mm long, ca 1.5 mm wide; lower lobe ca 1.5 mm long, ca 1.5 mm wide. Fruit ca 2.5 cm long, ca 0.5 cm wide; retinacula 0.3 cm long; seeds discoid, ca 0.4 cm across, thickened for about 0.3 mm around the margin.

Distribution: Known only from the type locality, cited above (Fig. 1). *L. chartaceum* can be readily distinguished from the other 4-staminate species by its linear, equal calyx lobes whose length is ca 6 times the width (Fig. 5). In the other two 4-staminate species, the calyx lobes have a length not exceeding 3 times the width.

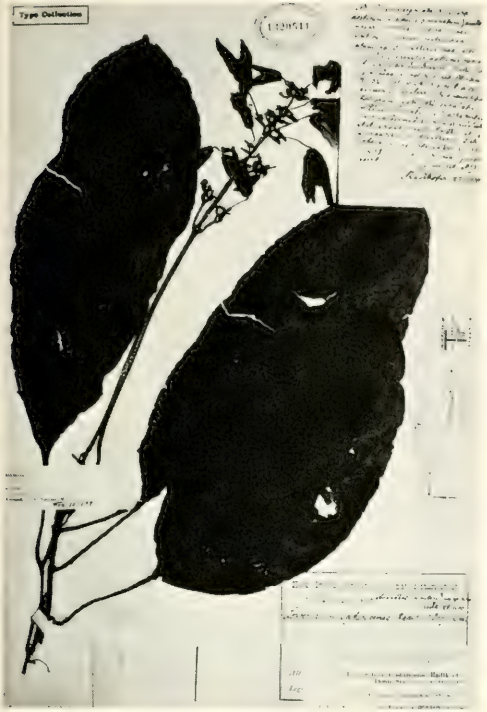


Figure 7. Photograph of *L. costaricense* Radlk & Donn-Sm., holotype.

Figure 8. Photograph of *L. tamaulipense* A. Richardson, holotype.

Section Louteridium

Stamens 2. Corolla white to purple, 5 cm or more in length; throat prominently gibbous; lobes rounded at the apex, elongate, length 3 times the width or greater (Fig. 6). Calyx lobes leaf-like and not conduplicate in 2 species, but conduplicate and not leaflike in 4 species. Internodes of the stem not in clusters.

Type species: L. donnell-smithii Wats.

The rather stable internode lengths in this section tend to indicate a long growing season and perhaps that these plants are evergreen.

4. *Louteridium costaricense* Radlk. & Donn.-Sm., Bot. Gaz. (Crawfordsville) 37:422. 1904. (Holotype US!) Costa Rica. Tucurrique, Las Vueltas, 1000 m, Mar 1899, Tonduz 8123.

A woody plant, glabrous in all parts. Leaves entire or irregular; blade 21–26.5 cm long, 9.5–11 cm wide, elliptic, attenuate at the apex, the base attenuate; petiole 5.5–6.5 cm long. First internode of inflorescence elongate; stalk of lateral branches of axis reduced, ca 1.5 cm long or less; bracts sessile, opposite, connate for ca 0.5 mm at the base, persistent. Calyx brown, chartaceous, lobes loosely enclosing the bud, narrowly elliptic, acute at the apex, subequal; upper lobe ca 4 cm long, ca 1.1 cm wide; lateral lobes ca 3.4 cm long, ca 1 cm wide. Stamens 2, anthers ca 0.9 cm long. Pollen grains 170–190 μ in diam, sometimes with irregular echinoid protrusions from the pores. Stigmatic lobes equal, ca 3 mm wide.

Distribution: Known only from the type locality, cited above (Fig. 1).

Described from a specimen in bud only. *Louteridium costaricense* is morphologically similar to *L. tamaulipense* (Figs. 7 & 8), although the 2 species are widely separated geographically (Fig. 1). They are most easily distinguished by the glabrous inflorescence of *L. costaricense* and the pubescent inflorescence of *L. tamaulipense.*

5. *Louteridium tamaulipense* A. Richardson, Sida 3:448. 1969 (Holotype, consisting of 4 sheets TEX! 272981, 272982, 272983, 272984; Isotypes F! GH! MEXU! MICH! NY! UC!) Mexico. Tamaulipas: Rocky limestone slope in a wet forest about 5 km by road NW of Gómez Farías, 370 m, 30 Jun 1969, A. Richardson 1388.

Soft-wooded shrub 2–2.5 m tall. Old stems prostrate and sprawling on the rocks and sending out adventitious roots. Current season's growths arising singly and erect from the nodes. Leaves and stems glabrous. Leaves entire to finely denticulate; blade 15–23 cm long, 6–10.5 cm wide, ovate, attenuate at the apex, the base acute to attenuate; petiole 4–7 cm long. First internode of inflorescence axis glabrous, elongate, about five times the length of the second internode, with a pair of glabrous, sessile, leaflike bracts subtending the first pair of cymes; stalk of lateral branches of axis 6 cm long or less; the axis and branches at and above the first node moderately viscid, and pubescent with several-celled glandular white hairs (Fig. 15, C & D); bracts caducous. Calyx greenish white on living plants but on pressed specimens green, chartaceous, pubescent on both surfaces, loosely enclosing the bud but enclosing the fruit more tightly; lobes equal, lanceolate, ca 3.6 cm long, ca 1.1 cm wide. Corolla greenish-white on living plants but on pressed specimens brown, lightly pubescent; tube ca 0.3 cm long, ca 0.7 cm diameter; throat ca 2.5 cm long, ca 2.3 cm across; lobes unequal, 2.7–3.2 cm long and tapering, with the upper 2 revolute and the lower 3 contorted (Fig. 6). Stamens 2, glabrous; anthers ca 1.5 cm long. Pollen grains 130–180 μ in diam, sometimes with irregular echinoid protrusions from the pores. Ovary pubescent with glandular hairs especially above, and on the lower part of the style; stigmatic lobes unequal; upper lobe ca 2 mm long, ca 0.5 mm wide; lower lobe ca 3.4 mm long, ca 0.5 mm wide. Fruit ca 3.3 cm long, ca 0.8 cm wide, retinacula ca 0.3 cm long; seeds discoid, 0.4–0.5 cm across and thickened for about 0.5 mm around the margin.

Distribution: Known only from the type locality, cited above (Fig. 1). This species grows on rocky limestone slopes in a forest described by Martin (1958) as a tropical semi-evergreen and evergreen forest characterized by *Abutilon* sp, *Achatocarpus mexicanus*, *Brosimum alicastrum*, *Celtis monoica*, *Dendropanax arboreus*, *Enterolobium* sp, *Ficus* sp, *Gymnanthes actinostemoides*, *Iresine tomentella*, *Quercus germana*, *Tabernaemontana citrifolia*, *Ungnadia speciosa*, and *Viburnum* sp.

Louteridium tamaulipense and *L. costaricense* are not as easily distinguished as are the other 7 species. However, they are widely separated geographically (Fig. 1), and the former is pubescent on the inflorescence, whereas the latter is completely glabrous.

6. *Louteridium conzattii* Standl., Contr. U.S. Natl. Herb. 23:1338. 1926. (Holotype US! Isotype US!) Mexico. Oaxaca: Between Jalapa and La Raya, on left bank of Rio Grande, district of Tuxtepec, 450 m, 3 Nov 1919, E. Conzatti 3788.

Leaves glabrous; blade 20.5–21.5 cm long, 16.5–17.5 cm wide, cordate, attenuate and curved downward at the apex, finely crenulate and undulate, many cystoliths prominent on both surfaces; petiole ca 4.5–6.2 cm long. Inflorescence pubescent only at the nodes (Fig. 15A); heavily bracteate, bracts glabrous, persistent, sessile, leaflike in shape and veining, ca 5.5 cm long, ca 3 cm wide at the base but smaller toward the apex; stalk of lateral branches of axis somewhat reduced, ca 1.4 cm long or less. Pedicel ca 3.9 cm long. Calyx imbricate, closely enclosing the bud; upper lobe ovate, acuminate at the apex, the base truncate, ca 2.2 cm long, ca 1.2 cm wide, conduplicate to enclose the upper halves of the 2 lateral lobes; lateral lobes falcate, ca 2 cm long, ca 0.9 cm wide. Corolla lightly pubescent with glandular hairs. Stamens 2, each coalescent with a much reduced sterile filament; filaments pubescent at the base; anthers ca 1 cm long. Pollen grains 190–200 μ in diam, sometimes with irregular echinoid protrusions from the pores. Stigmatic lobes equal, ca 1.5 mm long, ca 1.5 mm wide.

Distribution: Known only from the type locality, cited above (Fig. 1).

Described from specimens having only detached leaves and an inflorescence with flowers in bud. *Louteridium conzattii* can be quickly identified by its 2 stamens, conduplicate dorsal calyx lobe, and its cordate,

Figure 9. Photograph of *L. conzattii* Standl., holotype.

Figure 10. Photograph of *L. parayi* Miranda, isotype.

glabrous leaves and bracts (Fig. 9). *L. donnell-smithii* occasionally has subcordate leaves, but they are heavily pubescent.

A sterile specimen, Steyermark 37024 (F) has been included here with some reservation. It resembles *L. conzattii* but has some characters which suggest a relationship with *L. donnell-smithii*. The leaves are subcordate and pubescent along the veins with several-celled (occasionally one-celled) hairs, especially on the immature leaves. This specimen could represent a variant within *L. conzattii*, an undescribed species, or a hybrid between *L. conzattii* and the widespread *L. donnell-smithii*.

Additional specimen examined: GUATEMALA. SAN MARCOS: Between Todos Santos and Finca El Porvenir, on lower to middle slopes of Volcán Tajumulco, between 1300–3000 m, 1 Mar 1940, J. A. Steyermark 37024 (F).

7. *Louteridium parayi* Miranda, Ceiba 4: 140. 1954. (Isotype F!) Mexico. Chiapas: Evergreen forest near the Suspiro, about 9 km NW of Berriozabal, 950 m, 9 Jun 1953, L. Paray & Miranda 7834.

A glabrous, woody, sparsely branched epiphytic tree 1–3 m tall; cystoliths prominent on all parts. Leaves entire; blade 15–16 cm long, 3.5–4.5 cm wide, glabrous on upper surface (reported sparsely pilose on lower surface by Miranda), oblanceolate, acuminate at the apex, the base attenuate and decurrent on the petiole; petiole 1.25–1.5 cm long. Inflorescence glabrous, bracteate, bracts orbiculate, connate-perfoliate, ca 0.8 cm long, persistent. Calyx 3-lobed and enclosing the bud; upper lobe oblong, acute at the apex, the base truncate, ca 1.2 cm wide, ca 3 cm long, conduplicate, enclosing a small portion of the lateral lobes until the bud emerges, a pair of globose glands ca 0.2 cm in diam on the outer surface at the point of attachment to the pedicel; lateral lobes oblong, acute at the apex, the base truncate, ca 0.8 cm wide, ca 3 cm long, parting to about 45° from the dorsal lobe at anthesis. Corolla brown (reported pale yellow by Miranda); tube ca 0.1 cm long, ca 0.8 cm in diam; throat ca 3.3 cm long, ca 4.8 cm across; lobes ca 2.5 cm long and partially revolute. Stamens 2, pubescent

at the base with several-segmented hairs; anthers ca 1.5 cm long. Pollen grains 170–230 μ in diam. Ovary glabrous; stigmatic lobes equal, ca 5 mm long, ca 3 mm wide, pubescent.

Distribution: Known only from the type locality, cited above (Fig. 1).

Described from a specimen lacking a complete inflorescence. *Louteridium parayi* can be identified by its 2 stamens, the conduplicate, glandular dorsal lobe of the calyx, and the small, oblanceolate, glabrous leaves (Fig. 10).

8. *Louteridium mexicanum* (Baill.) Standl., Contr. U.S. Natl. Herb. 23:1338. 1926.

   Neolindenia mexicana Baill., Bull. Mens. Soc. Linn. Paris 2:851. 1889. Type from Mexico. Chiapas: Zacualpán.

   Louteridium purpusii T. S. Brandegee, Univ. Calif. Publ. Bot. 6:68. 1914. (Holotype UC! Isotypes F! GH! US!) Mexico. Chiapas: Finca Irlanda, Aug 1913, C. A. Purpus 6969.

Shrub or soft-wooded tree, 1.2–9.2 m tall; all parts glabrate or minutely puberulent. Leaves minutely puberulent on the lower surface with one-celled (rarely 2-celled) hairs, or sometimes glabrate, finely denticulate or entire; blade 18.5–40.5 cm long, 5.5–11.5 cm wide, obovate, acuminate at the apex, decurrent almost to the base of the petiole; petiole and midrib dull rose-purplish, veins greenish-white. Inflorescence finely puberulent with one-celled (rarely 2-celled) hairs (Fig. 15, H), and having small persisting bracts 0.5–1.5 cm long; first internode about twice the length of the succeeding one, the included node usually carrying only scars from deciduous bracts and aborted cymes, but rarely carrying leaflike bracts or a pair of cymes; stalk of lateral branches of axis reduced and compacted, ca 0.2 cm long. Pedicels 2.5–5 cm long. Calyx purplish-green, finely puberulent on both surfaces (Fig. 15, G), closely enclosing the bud; upper lobe ca 2.8 cm long, ca 1.6 cm wide, oblong, acute at the apex, the base truncate, conduplicate, enclosing the greenish-white upper halves of the 2 lateral lobes and remaining so at anthesis; lateral lobes falcate, ca 3.3 cm long, ca 0.9 cm wide. Corolla minutely puberulent, greenish-white outside, greenish-white tinged with pale lilac inside, protruding below the lateral lobes of the calyx; tube ca 0.8 cm diam, ca 0.8 cm long; throat ca 2.2 cm long, ca 4 cm across; lobes 2–2.5 cm long, the upper 4 revolute and the lower fifth lobe protruding downward at anthesis. Stamens 2, filaments pubescent; anthers ca 1.1 cm long. Pollen grains 190–200 μ in diam. Ovary pubescent, ca 0.5 cm long, ca 0.2 cm wide; style pubescent below. Stigmatic lobes unequal; upper lobe ca 2 mm long, ca 1.5 mm wide; lower lobe ca 2.5 mm long, ca 1.5 mm wide. Fruit ca 2.7 cm long, ca 0.6 cm wide. Retinacula ca 0.3 cm long. Seeds discoid, ca 0.4 cm across and thickened for about 0.5 mm around the margin.

Distribution: GUATEMALA, Depts. of San Marcos and Quezaltenango; and MEXICO, state of Chiapas, in wet wooded ravines, between 900–2000 m (Fig. 1).

The type specimen of *Neolindenia mexicana* has not been examined. However, the description by Baillon (1889) agrees with that of *Louteridium mexicanum*, and this was confirmed by Standley (1926).

A sterile specimen, Steyermark 36789 (F) has been included here with some reservation. The leaves are similar in shape to *L. mexicanum*, but differ from *L. mexicanum* in having a much longer petiole, and in being densely pubescent with several-celled hairs. It could represent an undescribed species or a possible hybrid between *L. mexicanum* and *L. donnell-smithii*, since the plant was collected in an area where the two species have overlapping distribution.

Louteridium mexicanum can be distinguished from the other 2-staminate species by its conduplicate dorsal lobe of the calyx, its greatly reduced and compacted stalks of the lateral branches of the inflorescence, and its minute puberulence (Figs. 11 & 12).

Representative specimens: GUATEMALA. SAN MARCOS: Finca El Porvenir, 11 Mar 1940, Steyermark 37501 (F); between Tajumulco and Tecutla, 27 Feb 1940, Steyermark 36789 (F). QUEZALTENANGO: Palmar, 14 Oct 1934, Skutch 1451 (A, F, US); Finca Pireneos, 1–2 Jan 1940, Steyermark 33435 (F); Finca Pireneos, 11 Mar 1939, Standley 68259 (A, F, US).

MEXICO. CHIAPAS: Chicharras, 6 Feb 1896, Nelson 3749 (GH, US); Finca Nubes, 2 Dec 1941, Miranda 1723 (US).

9. *Louteridium donnell-smithii* Wats., Proc. Amer. Acad. Arts 23:283. 1888. (Holotype US! Isotypes NY! US!) Guatemala,

Figure 11. Photograph of *L. mexicanum* (Baill.) Standl. (type for *L. purpusii* Brandg.).

Figure 12. Photograph of *L. mexicanum* (Baill.) Standl., representative specimen of the species.

Dept. Alta Verapaz: Pansamala, 1170 m, Feb 1886, H. von Tuerckheim 856.

Shrub or soft-wooded tree, 1.0–9.2 m tall, trunk up to 12.75 cm in diameter. Young floral parts, leaves, and stems densely soft-pubescent with several-celled hairs which often persist on older parts (Fig. 15 B). Leaves viscid, finely denticulate or sinuate; blade 11–42 cm long, 6.5–24.5 cm wide, ovate to subcordate, the apex acuminate; petiole 4–11.5 cm long. Inflorescence bracteate, bracts caducous; stalks of the lateral branches up to 12 cm long at base of panicle, ca 0.1 cm long at the apex. Pedicel 3–8.7 cm long. Calyx green, pubescent on dorsal lobe and on lower half of lateral lobes, closely enclosing the bud; dorsal lobe oblong, acute at the apex, the base truncate, ca 3.4 cm long, ca 1.2 cm wide, conduplicate and enclosing the upper, greenish-white halves of the 2 lateral lobes and remaining so after anthesis; lateral lobes falcate, ca 3 cm long, ca 0.7 cm wide. Corolla greenish-white to dark purple, protruding below the lateral lobes of the calyx, glabrous; tube ca 1 cm long, ca 0.7 cm in diam; throat 3–3.5 cm long, ca 5 cm across; lobes ca 1.7 cm long, revolute at anthesis. Stamens 2, filaments pubescent; anthers ca 1.4 cm long. Pollen grains 150–210 μ in diam, with echinoid protrusions which are regular in length and in distribution over the surface. Ovary ca 0.4 cm long, ca 0.2 cm in diameter, with glandular hairs. Stigmatic lobes unequal; upper lobe ca 2 mm long, ca 1 mm wide; lower ca 2.3 mm long, ca 1.3 mm wide. Fruit ca 2.5 cm long, ca 0.6 cm wide; retinacula ca 0.5 cm long; seeds ca 0.5 cm across and thickened for about 0.5 mm around the margin.

Distribution: BRITISH HONDURAS; GUATEMALA; HONDURAS; MEXICO, southern part. Commonly found on steep, rocky slopes in rain forests at altitudes of 60–1550 m (Fig. 1).

L. donnell-smithii can be distinguished from the other species with 2 stamens and

Figure 13. Photograph of *L. donnell-smithii* Wats., holotype.

Figure 14. Photograph of *L. donnell-smithii* Wats., representative specimen of the species.

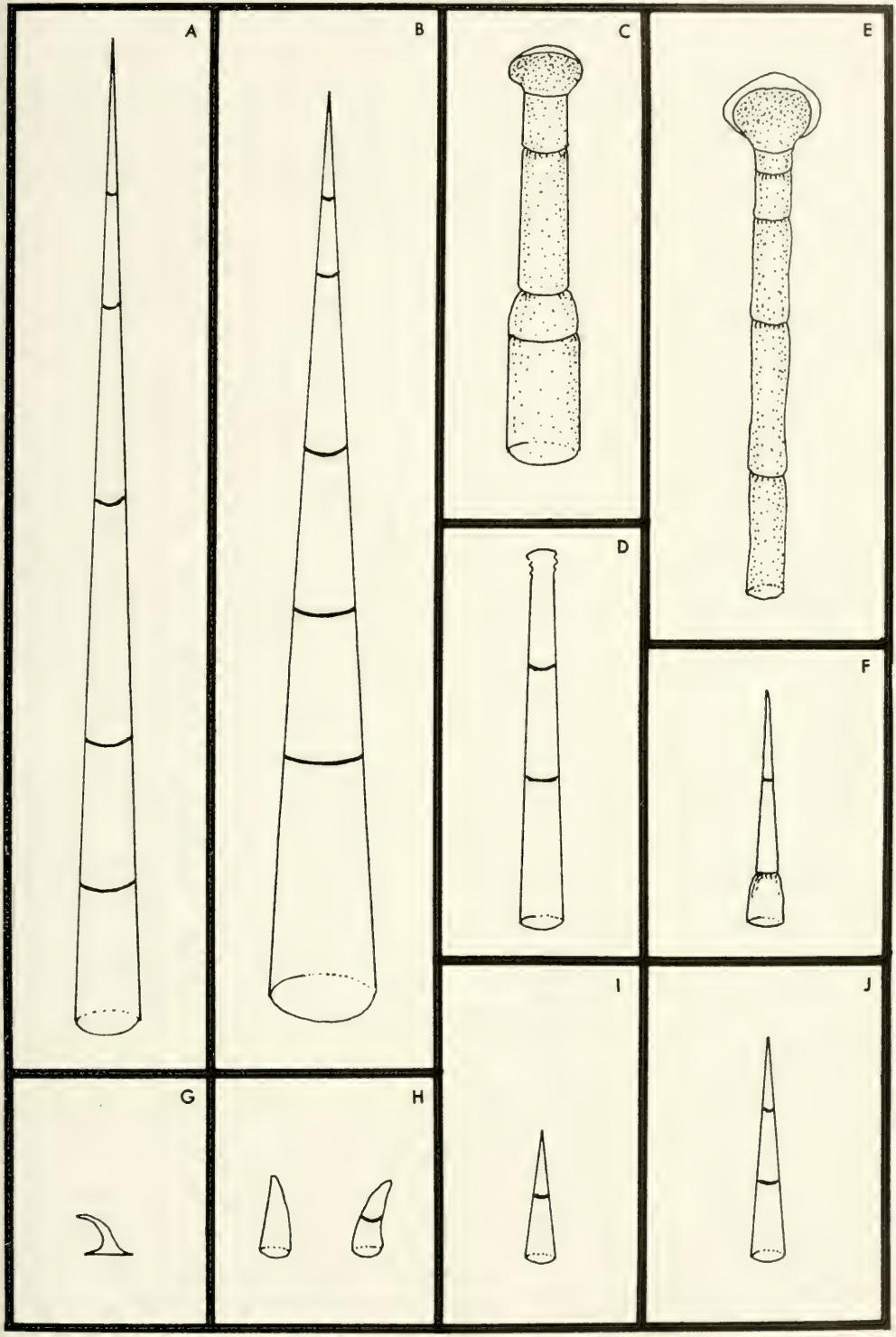
conduplicate dorsal lobes of the calyx by its densely pubescent, ovate to subcordate leaves (Figs. 13 & 14).

Representative specimens: BRITISH HONDURAS. TOLEDO: Fern Hill, 8 Jan 1933, Schipp 1110 (A, F, GH, MICH, NY, UC); Edwards Road beyond Columbia, 6 Jan 1948, Gentle 6355 (F, UC); 27 Mar 1907, Peck 780 (GH, NY).

GUATEMALA. ALTA VERAPAZ: Chucaneb, Apr 1889, J.D.S. 1620 (US); Cobán, 1908, Tuerckheim 2033 (GH, NY, US); vicinity of Cobán, 23 Mar–19 Apr 1941, Standley 91236 (F); N of Cobán, 15 Feb 1941, Hunnewell 17,320 (GH); near Cobán, 25 Feb 1942, Steyermark 44171 (F, US); Cubilquitz, Jan 1901, Tuerckheim 7936 (GH, NY, US); Pansamala, Apr 1889, J.D.S. 1621 (US); S of Santa Cruz, 28 Mar 1941, Standley 90192 (F); Sepacuite, 12 Dec 1904, Goll 155 (US); near the Finca Sepacuite, 27 Mar 1902, Cook & Griggs 205 (US); Sepacuite, 14 Jan 1904, Maxon 3282 (GH, NY, US); near Sepacuite, 18 May 1905, Pittier 320 (NY, US); Tactic, 9 Apr 1939, Standley 71094 (F); NW of Tactic, 15 May 1963, Molina R. & Molina 12303 (F); E of Tactic, 9 Apr 1939, Standley 71343 (F); near Tenahú, 16 Jan 1905, Maxon 3296 (NY, US); below Tenahú, 10 Apr 1941, Standley 91746 (F); Finca Trece Aguas, 10 Feb 1939, Wilson 180 (F). HUEHUETENANGO: Cerro Chiblac, 22 Jul 1942, Steyermark 49180 (F, US). IZABAL: W of Livingston, 16 Apr 1940, Steyermark 39562 (F); SSW of Puerto Barrios, 28 Feb 1966, Gregory 612 (F, US). PETÉN: Fallabón-Yaxha road, 22 Mar 1933, Lundell 2081 (F, MICH); Naranjo, 21 Mar 1922, Cook & Martin 79 (US). EL PROGRESO: Near Finca Caieta, 10 Feb 1942, Steyermark 43768 (F, MICH, US). VERA PAZ: 1885, Watson 292 (GH, US). ZACAPA: Volcán de Monos, 10 Jan 1942, Steyermark 42400 (F, US).

→

Figure 15. Drawings of hairs on *Louteridium*. 2 cm = 100 microns. A. Hair found on nodes of the inflorescence of *L. conzattii*. B. Hair of *L. donnell-smithii*. C. Glandular hair of *L. tamaulipense*. D. Glandular hair of *L. tamaulipense*. E. Glandular hair of *L. brevicalyx*. F. Hair on corolla and inner surface of calyx and bracts of *L. brevicalyx*. G. Hair on calyx of *L. mexicanum*. H. Hairs on inflorescence of *L. mexicanum*. I. Hair on inflorescence and calyx of *L. koelzii*. J. Hair on inflorescence and calyx of *L. koelzii*.


A
B
C
D
E
F
G
H
I
J

HONDURAS. COMAYAGUA: Pito Solo, 18 Apr 1945, Rodriguez 2940 (F); near Pito Solo, 11 Apr 1951, Williams & Molina R. 17730 (F); Siguatepeque, 24 Mar 1933, Edwards P-589 (A, F); near Taulabe, 8 Apr 1947, Standley, Williams, Molina R., & Chacon P. 7001 (F). CORTES: Near Pito Solo, 22 Mar 1962, Molina R. 10619 (F). SANTA BARBARA: Cerro Santa Barbara, 4 Apr 1951, Armour, Chable, & Allen 6047 (F, GH, US).

MEXICO. CHIAPAS: Ocosingo, 14 Apr 1967, Breedlove 15709 (US); San Quintín, 21 Mar 1955, Sohns 1684 (MICH, NY, UC, US).

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I wish also to express my appreciation to the curators and directors of the following herbaria for loans of specimens. Abbreviations after Lanjouw and Stafleu, 1964. Arnold Arboretum, Harvard University (A); Field Museum of Natural History (F); Gray Herbarium, Harvard University (GH); Herbario Nacional del Instituto de Biología, Universidad Nacional de México (MEXU); University Herbarium, University of Michigan (MICH); The New York Botanical Garden (NY); University of California, Berkeley (UC); U. S. National Herbarium (US).

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